Landsat 7 Processing System (LPS)
Output Files
Data Format Control Book

February 1998

GODDARD SPACE FLIGHT CENTER
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List of TBDs/TBRs

None

List of Outstanding CCRs

CCR LPS970208: Metadata requirement 3.3.4.13 not all in Output DFCB

CCR LPS970225: Browse- Clipping percentile - should be upper and lower

CCR LPS970235: PCD - gyro-select data - there should be 6 choices instead of 2

CCR LPS970240: CAL - cal_data_line_offset_rhs and cal_data_line_offset_lhs are type int8, but have values that can exceed an int8 data type

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Abstract

This Data Format Control Book (DFCB) presents detailed data formats of the output files generated by the Landsat 7 Processing System (LPS). The LPS produces output files for each subinterval identified in a Landsat 7 contact period, the raw wideband data received from the Landsat 7 Ground Station (LGS) during a Landsat 7 spacecraft direct downlink period. Each subinterval consists of an Enhanced Thematic Mapper Plus (ETM+) Format 1 and a Format 2 segment. The LPS output files include Level 0R files, a metadata file, and one or more multiband-scene browse file(s). The Level 0R files include a band data file (integer-pixel aligned) for each band of the ETM+ instrument, a mirror scan correction data (MSCD) file, a payload correction data (PCD) file, and a calibration data file. The LPS produces a separate set of Level 0R files for the ETM+ Format 1 and Format 2 subintervals. The LPS produces a total of six band data files (Bands 1–6) for an ETM+ Format 1 subinterval, and a total of three band data files (Bands 6–8, ignoring segmentation for Band 8) for an ETM+ Format 2 subinterval. The LPS produces multiband-scene browse files for the ETM+ Format 1 subinterval only. The LPS may produce up to 35 full multiband-scene browse files for a 14-minute subinterval. A metadata file is produced for each ETM+ format of a subinterval.

The LPS uses the Hierarchical Data Format (HDF) for storing these files in the LPS and for transferring to the EROS Data Center (EDC) Distributed Active Archive Center (DAAC). The EDC DAAC is being developed by the EOSDIS Core System (ECS) Project.

This document is based on the requirements contained in the *LPS Functional and Performance Specification (F&PS)* and the interface control document (ICD) between the ECS and the Landsat 7 System. It will be baselined by the LPS Project for delivering Landsat 7/LPS output data files to the EDC DAAC.

Keywords: Data Format Control Document (DFCB)
Hierarchical Data Format (HDF)
Landsat 7 Processing System (LPS)
EROS Data Center Distributed Active Archive Center (EDC DAAC)

Preface

This DFCB is controlled by the LPS Project of the Mission Operations and Systems Development Division (MOSDD) and may be updated by a Document Change Notice (DCN) or a revision. Comments and questions regarding this DFCB should be directed to:

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Goddard Space Flight Center
Greenbelt, MD 20771

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Section 1 — Introduction

1.1 Purpose

This data format control book (DFCB) defines detailed formats of the output (Level 0R, metadata, and multiband browse) files generated by the Landsat 7 Processing System (LPS). The LPS makes these files available, on a Landsat 7 contact period basis, for pick up by the EROS Data Center (EDC) Distributed Active Archive Center (EDC DAAC).

The LPS output file formats described in this DFCB are based on the requirements contained in the *LPS Functional and Processing Specification (F&PS)* and the *Interface Control Document (ICD) Between the EOSDIS Core System (ECS) and the Landsat 7 System (Applicable Document 2.1.2).*

1.2 Scope

This DFCB describes the data contents and Hierarchical Data Format (HDF) details for the LPS output files. The functional, performance, operational, and interface design details for the transfer of these files from LPS to the ECS EDC DAAC are contained in the ECS-L7 ICD. The contents of the LPS output files defined in this DFCB are based on the Landsat 7 ETM+ instrument and payload correction data (PCD) details contained in the *Landsat 7 Data Format Control Book, Volume IV - Wideband Data*, the *LPS F&PS*, the *ECS-L7 ICD*, and the HDF documents/specifications available from the ECS Project and/or the National Center for Supercomputing Applications (NCSA).

The file formats contained in this DFCB are applicable to the interface between the ECS EDC DAAC and the LPS. This DFCB does not contain specific details on the file formats for the Landsat 7 Level 0R products generally requested by the Landsat 7 users and provided by the ECS EDC DAAC. Detailed formats for the Level 0R products, required by the Landsat 7 users, are defined in a separate document, the *Landsat 7 0R Distribution Product DFCB* (Applicable Document 2.1.9).

1.3 Intended Users

This document is intended as a supplement to the *ECS-L7 ICD*. Therefore, the LPS and the EOSDIS Projects are the primary users of this document. This document contains detailed information on the LPS output data file formats to allow users on both project sides to proceed with independent development of the LPS and EDC DAAC (systems).

This DFCB provides detailed information on the contents of the LPS Level 0R output files (band, mirror scan correction data, payload correction data, and calibration data) and the metadata and multiband-scene browse files associated with the L0R processed subinterval. Both the EDC DAAC and Landsat 7 users are interested in this data. The primary intention of the data formats contained in this DFCB is to support the development of the direct interface between the LPS and the EDC DAAC. The Level 0R details contained in this DFCB, though useful, are not intended for use by the Landsat 7 users. Complete details on the Landsat 7 Level 0R products desired by the Landsat 7 user/scientist community are defined in a separate Landsat 7 project document, the *Landsat 7 0R Distribution Product DFCB (Applicable Document 2.1.9).*

This DFCB should be used in conjunction with the *Landsat 7 System Data Format Control Book (DFCB), Volume IV - Wideband Data* (Applicable Document 2.1.4) to get complete details on the band (ETM+ major and minor frame structures), the MSCD, the PCD (cycle, major frame, and minor frame organization), and the calibration (starting and ending minor frames for each band) data included in the LPS Level 0R output files. Complete details on the HDF data structures used in construction of LPS output files are provided in the following applicable documents (also listed in Section 2):

1. Hughes Applied Information Systems, Inc., *HDF-EOS Primer for Version 1 EOSDIS*, White Paper, 175-WK-001-001, April 1995.

2. Hughes Applied Information Systems, Inc., *The HDF-EOS Swath Concept*, White Paper, 170-WP-003-001, December 1995.

3. CCSDS Recommendation for Space Data System Standards, *Parameter Value Language - A Tutorial, CCSDS 641.0-G-1, Green Book Issue 1*, May 1992.

4. GSFC, *EOSDIS Browse Delivery Package Description*, Preliminary Draft, June 23, 1995.

5. University of Illinois at Urbana-Champaign, National Center for Supercomputing Applications (NCSA), *HDF User's Guide*, June 1995.

6. University of Illinois at Urbana-Champaign, National Center for Supercomputing Applications (NCSA), *HDF Reference Manual*, February 1994.

7. Hughes Information Technology Corporation, *HDF-EOS User's Guide for the ECS Project*, Revision 1 (Draft), April 1996.

1.4 Definitions

The following terms, as defined in this section, are commonly used throughout this document to clarify the scope, contents, and format of LPS output files.

1. Landsat 7 Contact Period: The time duration between the start and end of raw wideband data transmissions from the Landsat 7 spacecraft to a ground station [e.g., the Landsat 7 Ground Station (LGS)]. Figure 1-1 illustrates the Landsat 7 contact period concept.

2. Interval: The time duration between the start and end of an imaging operation (land observation) by the ETM+ instrument on board the Landsat 7 spacecraft. The raw wideband data collected during an interval consists of a contiguous set of WRS scenes.

3. Subinterval: A segment of a raw wideband data interval received during a Landsat 7 contact period. Subintervals are caused by breaks in the wideband data stream due to communication dropouts and/or the inability of the spacecraft to transmit a complete observation (interval) within a single Landsat 7 contact period. The largest possible subinterval can be as long as a full imaging interval (a set of contiguous WRS scenes) transmitted during an uninterrupted contact period. The smallest possible subinterval can be as small as a set of a few contiguous ETM+ scans (a partial WRS scene). The smallest size of a subinterval is an operator modifiable parameter in LPS. If the smallest subinterval size is chosen to be as long as a full WRS scene, it will contain approximately 24 seconds worth of ETM+ data or 335 scans (without the 20 overlapping scans each, at top and bottom, between adjacent scenes). The ETM+ raw wideband data, collected for a single imaging observation by the Landsat 7 spacecraft, is received in two parts, ETM+ Format 1 and ETM+ Format 2, by the LPS. The LPS produces a separate subinterval (part) for each ETM+ format. Figures 1-1 and 1-2 illustrate the subinterval concept.

4. ETM+ Format 1: The ETM+ Format 1 major frames contain all data (e.g., imaging and calibration) from and associated with Bands 1–6. The MSCD and PCD data are duplicated in both ETM+ formats.

5. ETM+ Format 2: The ETM+ Format 2 major frames contain all data (e.g., imaging and calibration) from and associated with Bands 6–8. The MSCD and PCD data are duplicated in both ETM+ formats.

6. LPS String: A functional and physical entity of the LPS responsible for the end-to-end processing of either Format 1 or Format 2 ETM+ raw wideband data received via a return link channel (I or Q) of an X-band downlink from the LGS.

7. LPS (output) Files: The generic term used to denote the grouping of Level 0R, browse, and metadata files for a single subinterval. See Figure 1-2.

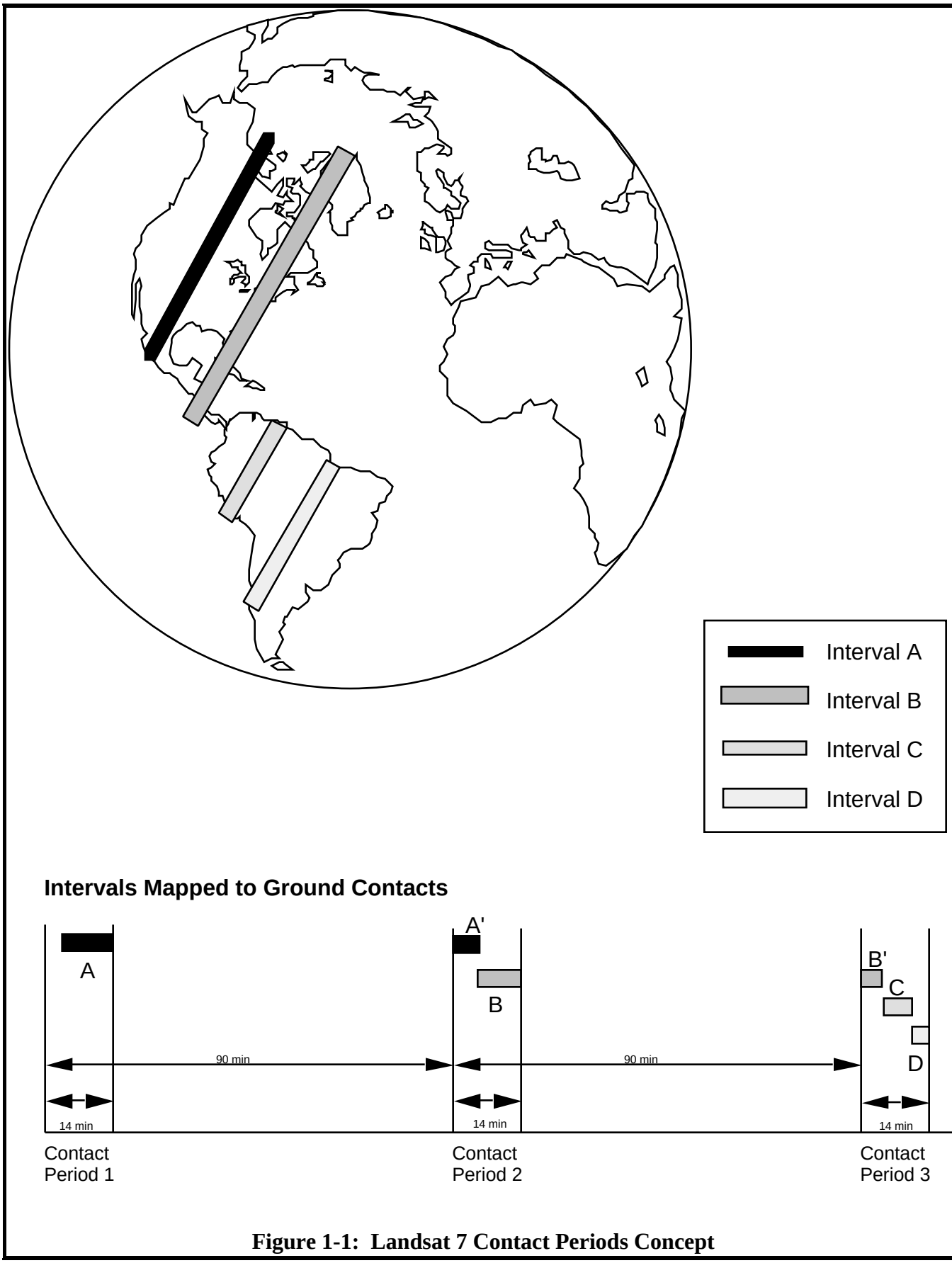
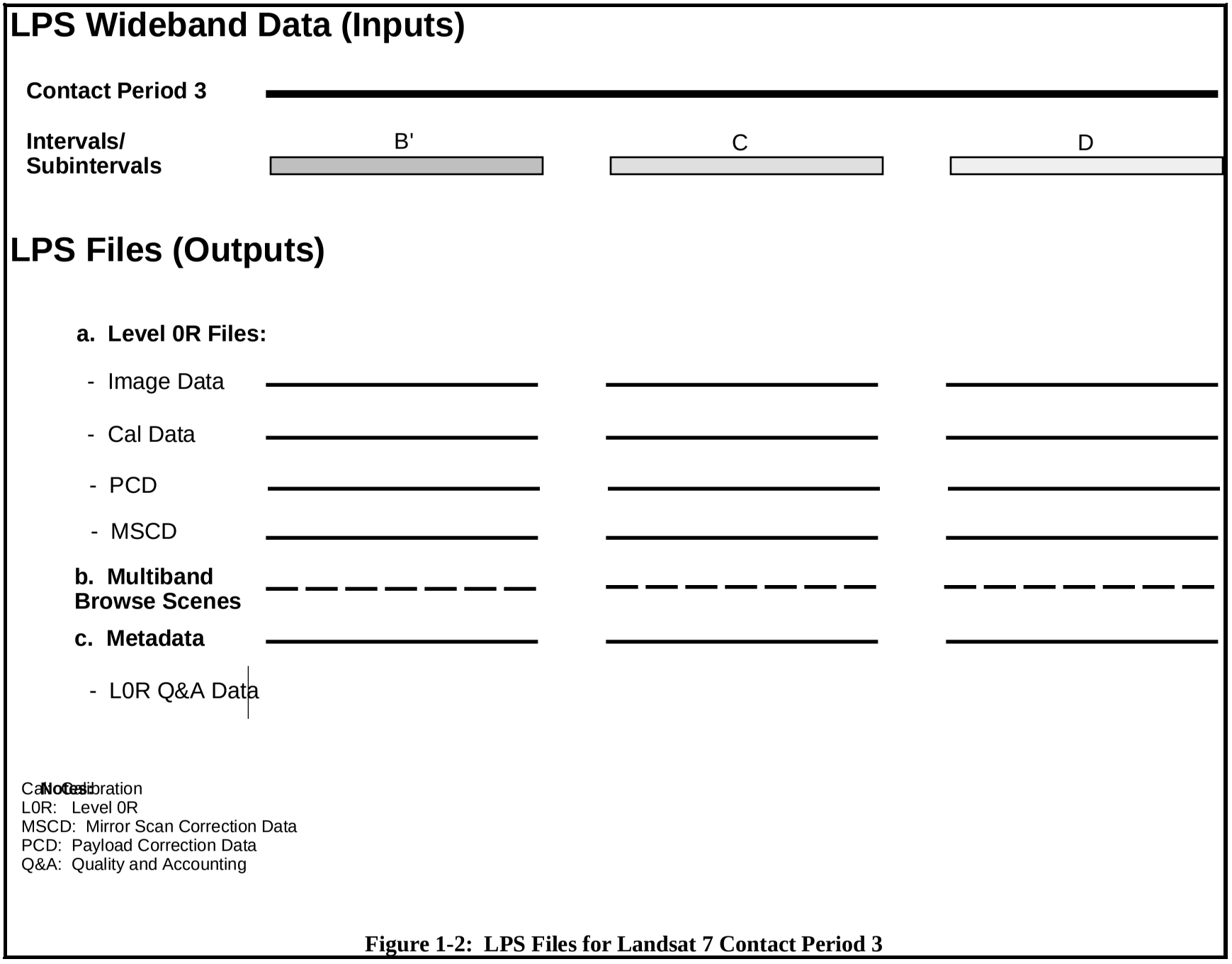


Figure 1-1: Landsat 7 Contact Periods Concept



Notes:

Figure 1-2: LPS Files for Landsat 7 Contact Period 3

8. Level 0R Files: The generic term used to denote the grouping of band, MSCD, PCD, and calibration data files for a single subinterval. See Figure 1-2.

9. Level 0R Quality and Accounting Data: The data quality and accounting information collected by the LPS, on a subinterval basis, from processing of the ETM+ major frames constructed from the wideband Virtual Channel Data Units (VCDUs) received during a Landsat 7 contact period.

10. Scan: A scan results from a cross-track motion of the ETM+ instrument and consists of detector sensed data from all bands. Each of the ETM+ Bands 1 through 5 and 7 produce 16 detector data lines during each scan. Bands 6 and 8 produce 8 and 32 detector data lines during each scan.

11. Scan Line: An image data line produced from a single detector of a band during a scan.

12. Upper Corners: The upper corners of a scene are the corners associated with the trailing edge (first scan) of a scene. For descending path scenes, the upper left corner corresponds to the north-west corner of a scene and the upper right corner corresponds to the north-east corner of a scene. For ascending path scenes, the upper left corner corresponds to the south-east corner of a scene and the upper right corner corresponds to the south-west corner of a scene. These mappings hold for the band file geolocation fields and the metadata file. See Figures 1-3 and 1-4 for the context of the corners with respect to the spacecraft and the image display.

13. Lower Corners: The lower corners of a scene are the corners associated with the leading edge (last scan) of a scene. For descending path scenes, the lower left corner corresponds to the south-west corner of a scene and the lower right corner corresponds to the south-east corner of a scene. For ascending path scenes, the lower left corner corresponds to the north-east corner of a scene and the lower right corner corresponds to the north-west corner of a scene. These mappings hold for the band file geolocation fields and the metadata file. See Figures 1-3 and 1-4 for the context of the corners with respect to the spacecraft and the image display.

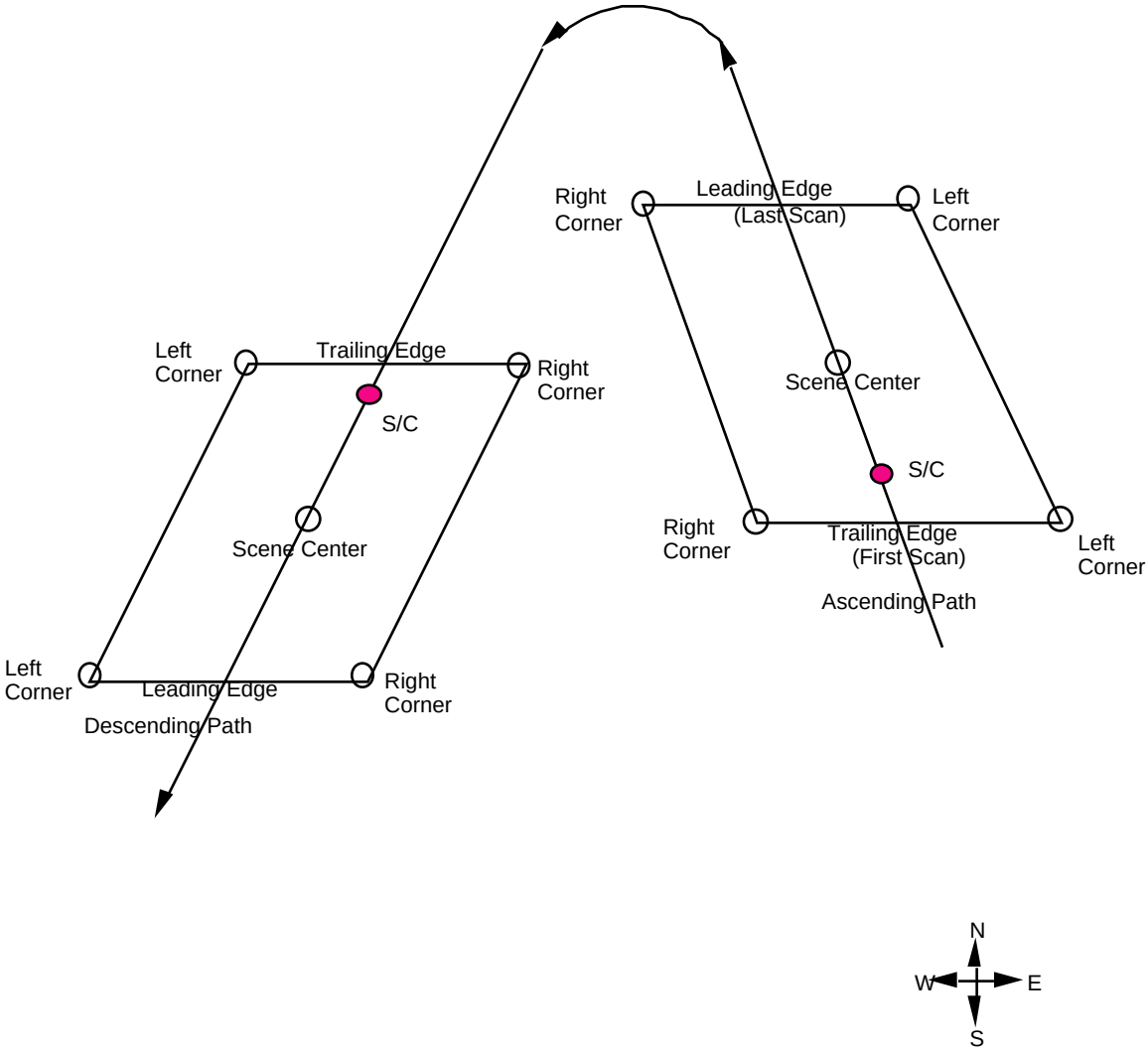
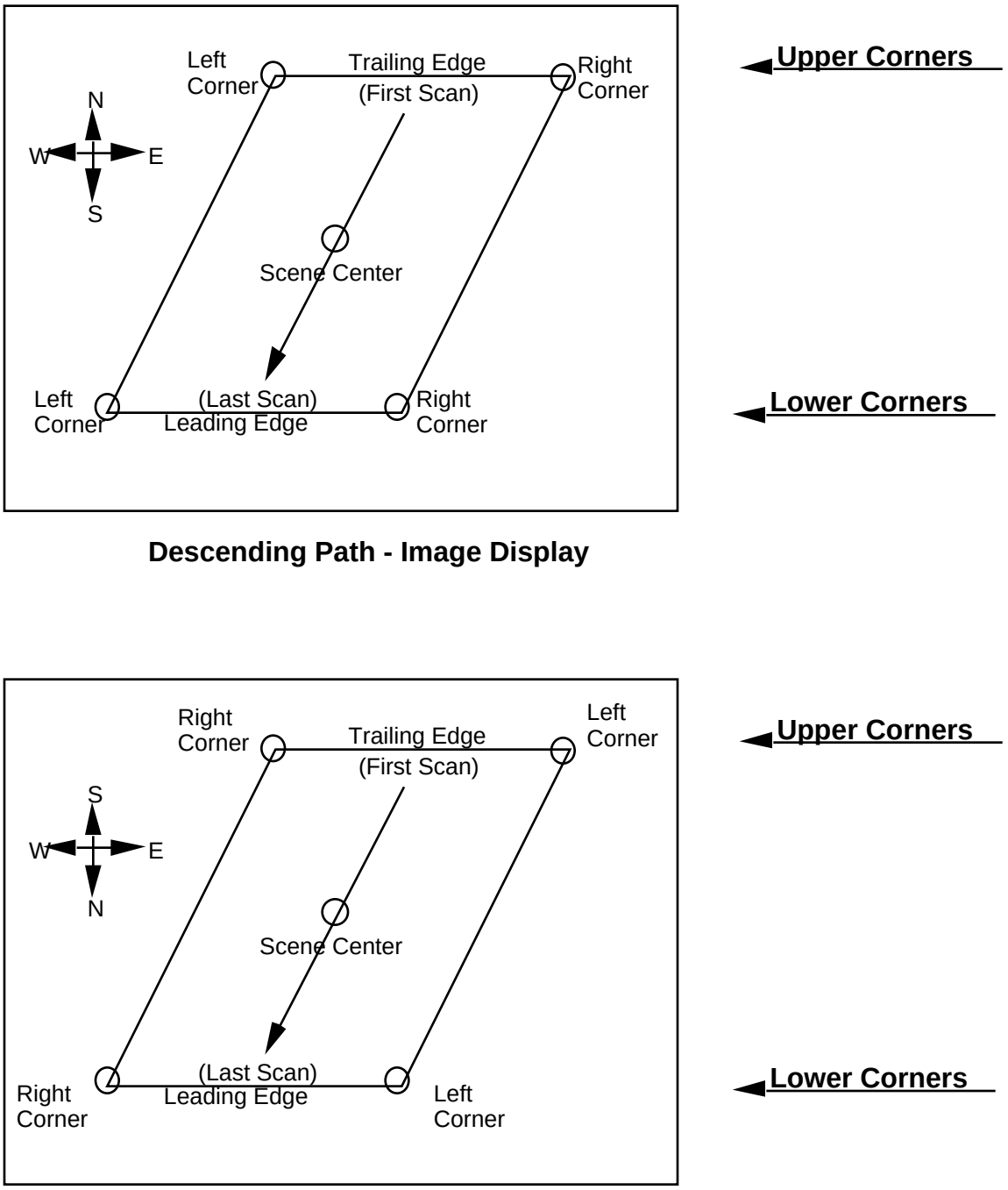


Figure 1-3. WRS Scene Corners Context (1 of 2)



Descending Path - Image Display

Ascending Path - Image Display

Figure 1-4. WRS Scene Corners Context (2 of 2)

1.5 HDF Data Types

The following data types are used throughout this DFCB:

HDF C Language Notation	Data Type	No. of Bytes
char8	**8-bit ASCII character**	**1**
int8	**8-bit signed integer**	**1**
uint8	**8-bit unsigned integer**	**1**
int16	**16-bit signed integer**	**2**
uint16	**16-bit unsigned integer**	**2**
int32	**32-bit signed integer**	**4**
uint32	**32-bit unsigned integer**	**4**
float32	**32-bit floating point number**	**4**
float64	**64-bit floating point number**	**8**

In addition, the following terms are synonymously used to denote the length of a given data type field in an LPS and/or HDF data structure (Vdata, Swath, etc.):

Order: This term denotes the number of items of the Vdata type as shown. For example, if the data type is 'uint16' with an order of '2', the HDF field size is 4 bytes.

Count: This term denotes the number of items of the data type as shown.

Size: This term denotes the size of an LPS file attribute/field in total number of bytes.

Section 2 — Documentation

The following documents provide additional detail and reference information regarding the format of LPS output files. Except in the case of the *LPS F&PS*, if any information contained in these documents conflicts with this DFCB, the contents of the DFCB shall prevail .

2.1 Applicable Documents

1. NASA GSFC/MO&DSD, Landsat 7 Processing System (LPS) Functional and Performance Specification (F&PS), Revision 2, 560-8FPS/0194, January 20, 1998.

2. NASA GSFC, Interface Control Document (ICD) Between the EOSDIS Core System (ECS) and the Landsat 7 System, Revision B , 505-41-32, January 1998.

3. National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) Landsat 7 Detailed Mission Requirements, December 1996.

4. Lockheed Martin Missiles and Space, Landsat 7 System Data Format Control Book (DFCB), Volume IV - Wideband Data, Revision F, 23007702-IVF, May 29, 1997.

5. Hughes Applied Information Systems, Inc., HDF-EOS Primer for Version 1 EOSDIS, White Paper, 175-WK-001-001, April 1995.

6. Hughes Applied Information Systems, Inc., The HDF-EOS Swath Concept, White Paper, 170-WP-003-001, December 1995.

7. CCSDS Recommendation for Space Data System Standards, Parameter Value Language - A Tutorial, CCSDS 641.0-G-1, Green Book Issue 1, May 1992.

8. GSFC, EOSDIS Browse Delivery Package Description, Preliminary Draft, June 23, 1995.

9. GSFC, Landsat 7 0R Distribution Product Data Format Control Book, Volume 5, 430-11-06-007-0, Revision 1, February 1998.

10. University of Illinois at Urbana-Champaign, National Center for Supercomputing Applications (NCSA), HDF User's Guide, June 1995.

11. University of Illinois at Urbana-Champaign, National Center for Supercomputing Applications (NCSA), HDF Reference Manual, February 1994.

12. Hughes Information Technology Corporation, HDF-EOS User's Guide for the ECS Project, Revision 1 (Draft), April 1996.

13. National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC), Landsat 7 to International Ground Station (IGS) Interface Control Document, 430-11-06-009-00, Revision B, February 1998.

14. NASA GSFC/MO&DSD, Landsat 7 Processing System (LPS) Software Requirements (SRS), Revision 2, 560-8SWR/0195, August , 1997.

Section 3 — LPS Output Files Overview

3.1 Level 0R Files

The primary outputs of the LPS consist of Level 0R files, the metadata (file), and multiband-scene browse files. The Level 0R files include ETM+ instrument band (image) data, mirror scan correction data (MSCD), payload correction data (PCD), and calibration data files. The band file(s) contain the Level 0R processed science data collected from the Landsat 7 ETM+ instrument. A Level 0R band file contains reformatted, unrectified, subinterval data having a sequence of pixels that is spatially consistent with the ground coverage. The radiometric calibration, attitude, and ephemeris data, associated with the band file, are provided in the payload correction and calibration data files. The MSCD file provides additional scan-related information for subsequent processing of the band file data to Level 1R/1G. The LPS provides one set of Level 0R data and a metadata file for each ETM+ data format: Format 1 and Format 2. The multiband scene browse data files are provided for Format 1 data only. These data formats are associated with Bands 1–6 and Bands 6–8 of the ETM+ instrument, respectively.

The following sections describe the Landsat 7 Level 0R data contents of LPS output files. Details about LPS file formats, using the HDF file structures, are provided in Section 4.

The LPS Format 1 output contains 10 Level 0R files plus from 1 to 35 full multiband-scene browse files. Format 2 output contains 7–10 files depending on the size of Band 8 (1–3 segments).

3.1.1 Band Data File(s)

The LPS generates two sets of band files, one each for ETM+ Format 1 and ETM+ Format 2 Data. Bands 1–6 files are generated for the ETM+ Format 1 data. Bands 6–8 files are produced for the ETM+ Format 2 data. The Band 8 data, which could exceed the 2 GB restriction for HDF files, is contained in as many as three file segments. The number of Band 8 file segments produced by LPS depends on the size/duration of a Level 0R processed subinterval. The largest size Band 8 subinterval to be processed by LPS is expected to be approximately 5 GB (35 full scenes for a 14-minute subinterval/contact period).

Each band file contains detector (scan line) data produced by a single band during a Level 0R processed subinterval. All scan lines for all bands are constructed from the ETM+ data (minor frames) located between the timecode and the End of Line Code minor frames. The scan line data is grouped by detectors such that, for a given major frame, detector 16 data is followed by detector 15 data, detector 15 data is followed by detector 14 data, and so on. Pixel order for the reverse scans is reversed before insertion into band files. This data is nominally aligned using fixed and predetermined integer-pixel values to provide alignment for band offset,

odd/even detectors, and to accommodate for the forward-reverse scanning pattern of the ETM+ instrument. To avoid data duplication, ETM+ data quality and accounting information is provided in the MSCD file. This information includes counts of BCH corrected and uncorrected VCDUs, as well as ETM+ major frame synchronization errors corresponding to band data lines in a scan.

The LPS uses the HDF-EOS swath format for producing the band file(s). Section 4.1.1 provides details on the swath format of the LPS band file(s).

3.1.2 Mirror Scan Correction Data File

Two MSCD files are generated by LPS from each subinterval found in a contact period. One MSCD file is created for each ETM+ data format, Format 1 and Format 2, of a subinterval. Both the Format 1 and Format 2 MSCD files are expected to contain exactly the same MSCD unless one format, received by an LPS string, contains more errors than the other. An MSCD file consists of data records for each major frame (ETM+ scan) received in a subinterval. Each MSCD record contains the Scan Line Data (SLD) extracted from the two minor frames following the End of Line (EOL) Code in each major frame of a subinterval. The SLD includes the first half scan error (FHS ERR), the second half scan error (SHS ERR), and the scan direction (SCN DIR) information for the previous ETM+ scan. The spacecraft time associated with the SLD source major frame is also appended with each MSCD record. Data quality information, such as counts of BCH corrected and uncorrected VCDUs and the number of CADUs detected with bit slip errors, is also provided on a major frame (ETM+ scan) basis for each MSCD record.

The LPS uses the HDF-EOS Point structure format for generating the MSCD file. Section 4.1.2 describes the HDF-EOS Point format for the LPS MSCD file.

3.1.3 Payload Correction Data File

A PCD file is generated by the LPS for each subinterval found in a contact period. Separate PCD files are created for the ETM+ Format 1 and Format 2 data in a subinterval. Both the Format 1 and Format 2 PCD files are expected to contain exactly the same PCD unless one format, received by an LPS string, contains more errors than the other. A PCD file contains all PCD major frames received during a subinterval. Each PCD major frame is repeated at the PCD cycle rate. A PCD cycle consists of four unique major frames identified as PCD major frames (0), (1), (2), and (3). The PCD for each major frame is provided in engineering units (EUs), as appropriate. The PCD quality and accounting information, such as missing PCD words and PCD byte voting errors, is included in each PCD major frame. Partially received/assembled PCD minor and major frames are filled. Missing PCD major frames are also substituted with filled major frames.

The LPS uses the HDF Vdata format for generating the PCD file. Section 4.1.3 describes the HDF Vdata format for the LPS PCD file.

3.1.4 Calibration Data File

The LPS generates two calibration data files, one each for ETM+ Format 1 and Format 2, for each subinterval. The Format 1 file contains all calibration data for Bands 1–6. The Format 2 file contains all calibration data for Bands 6–8.

The calibration data in each file is organized in a band sequential manner such that all calibration data for Band 1 is grouped first, followed by all calibration data for Band 2, and so on. The calibration data for each band consists of all band deinterleaved detector data from all minor frames, starting with the EOL minor frames, of all ETM+ scans in a subinterval. Data from each detector in a scan is used to form a single calibration data line in a band group. For a given band, calibration data from all detectors is grouped in a scan incrementing/detector descending sequence (i.e., Scan 1/Detector 16, Scan 1/Detector 15, Scan 1/Detector 14 ... Scan 2/Detector 16, Scan 2/Detector 15, Scan 2/Detector 14, and so on) to form calibration data lines. Reverse scans (calibration data lines) are reversed during construction of a calibration file. All calibration data lines, forward and reverse, are aligned by applying the same integer-pixel shifts used in aligning the band data lines. The time of the ETM+ major frame corresponding to each calibration data line is also provided to support the swath structure (used as geolocation information).

Each calibration data line contains all band-detector data starting after the 2 Scan Line Data (SLD) minor frames in the current scan until the start of the Line Sync Code (LSC) for the next ETM+ scan. Thus, each scan/detector calibration data line contains all calibration and fill data found between the SLD and the next LSC, in subsequent byte locations. No calibration data (scan/detector words and/or minor frames) are dropped/omitted while constructing a calibration data line. Detailed information on the locations of calibration data bytes, located between the SLD and LSC in an ETM+ scan, is provided in the *Landsat 7 Wideband Data DFCB* (Applicable Document 2.1.4). The ETM+ data quality and accounting information such as counts of BCH corrected and uncorrected VCDUs and ETM+ major frame synchronization errors, corresponding to each scan containing band and calibration data lines, is provided in the MSCD file.

The LPS provides the original location (minor frame counter value) of the first minor frame of the EOL code, for each ETM+ scan, in the MSCD file. The EOL original location can later be used as a reference to determine the actual location (distance from the first minor frame of the EOL code) of each calibration data sample (band-detector data) in an ETM+ scan.

The LPS uses the HDF-EOS swath format for generating the calibration data file. Section 4.1.4 describes the HDF swath format for the LPS calibration data file.

3.2 Metadata File

A metadata file is generated by LPS for each subinterval found in a contact period. The LPS generates a metadata file for each ETM+ data format, Format 1 and Format 2, of a subinterval. The Format 1 metadata file contains identification and

quality and accounting information on the Level 0R processed data for Bands 1–6. Similarly, the Format 2 metadata file contains identification and quality and accounting information on the Level 0R processed data for Bands 6–8.

A metadata file contains information on the Level 0R processed data contained in a Format 1 or Format 2 subinterval: the names of all band data, calibration data, payload correction data, mirror scan correction data, and multiband-scene browse files. The metadata also includes quality and accounting information on the return link wideband data used in generating the Level 0R file(s). In addition, metadata includes quality and accounting information on received and processed PCD and cloud cover assessment for the WRS scenes, full or partial, contained in the associated subinterval. The metadata is used by EDC DAAC users to determine quality of the Level 0R data in the archive before ordering it.

The LPS uses the ODL format for generating the metadata file. Section 4.2 provides the ODL format required details for the LPS metadata file.

3.3 Multiband-Scene Browse Files

A multiband-scene browse file is a reduced data volume file of the Level 0R band/image data which can be viewed on a scene basis to determine general ground area coverage and spatial relationships between ground area coverage and cloud coverage. The multiband-scene browse data from three predetermined bands of the ETM+ Format 1 data are contained in a multiband-scene browse file. The LPS generates a multiband-scene browse file from each of the full resolution scenes (band-detector image data) contained in the three predetermined Level 0R band data files of a subinterval.

Partial scenes are identified similarly to full scenes. Partial scenes band data, if received, will be located at the start and end of a subinterval and provided as the first and the last browse scenes of the subinterval. At present, a maximum of 35 full WRS scenes are expected in a 14-minute long subinterval.

The LPS uses the HDF RIS24 format for generating the multiband-scene browse file. Section 4.3 provides HDF RIS24 format required details for the LPS multiband-scene browse file.

3.4 File Naming Convention

The ECS and LPS projects have agreed to the following convention for naming the LPS output files:

File Name: L7XsssfnYYDOYHHuuv.xxx where

Description	Remarks
L7 indicates the Landsat 7 mission	Fixed to "L7" for all files generated by LPS
X = 1, 2, or 3 for the L7 X-band data routed by LGS to an LPS String	Obtained by LPS from the Landsat 7 contact period schedule and the matrix switch connection information received from LGS. 1 = XL (low frequency). 2 = XM (medium frequency). 3 = XH (high frequency). This is the nominal mapping of the numerical value of the capture source in the configuration table. For files received on tape from AGS and SGS, the current value for the string will be used unless specified otherwise.
sss indicates data capture and Level 0R processing ground station, for example: sss = "EDC" at Sioux Falls, SD	A parameter entered by the operator at LPS initialization or prior to Level 0R processing. For tapes received from other stations use the IGS station ID, AGS for Fairbanks, Alaska and SGS for Svalbard, Norway. See the *L7 to IGS ICD* (Applicable Document 2.1.13) for the full set of IGS stations.
f indicates ETM+ data format: f = 1 for Format 1 data f = 2 for Format 2 data	Identifies the ETM+ Format 1 or 2 data contained in this file. The ETM+ format information is taken from the "PCD/Status Data" field of the first error-free VCDU of the first major frame of the subinterval reported in this file.
n indicates LPS processor number (1–9)	A predetermined number for each LPS string. Only 5 LPS strings are available now.
YYDOYHH: indicates the Landsat 7 contact period start date and time for this file, where YY = The last two digits of the year associated with a contact period DOY = The Julian day (001 through 366) associated with the contact period HH = The hour of the contact period within a 24-hour day (00–23)	The Julian date and Greenwich Mean Time (GMT) when the capture of a Landsat 7 contact period, associated with this subinterval, was started by the LPS. For raw data tapes received from other Landsat 7 ground stations**, this time is expected to be available from the tapes. ** It is assumed that other Landsat 7 ground stations will comply with the LPS internal data format specification for Landsat 7 raw wideband data tapes.

Description	Remarks
uu indicates a subinterval number within this contact period (01–99)	Generated by LPS during Level 0R processing.
v indicates file version number: v = 0 for the L0R processed data generated during the first processing run of a contact period. v = 1–9 for reprocessed Level 0R data generated during subsequent processing runs of the same contact period.	A reprocessing indicator used to distinguish the Level 0R files generated from a single contact period during multiple processing runs. The reprocessing information is entered by an operator during setup of a Level 0R processing operation.
xxx indicates an LPS File type: where: xxx = Bis for band files where or B indicates a band file, i indicates ETM+ band IDs 1–8 s indicates a file segment number or type s = 0 for single segment files for Bands 1–7 s = 1–3 for Band 8 file segments or xxx = "MSD" for an MSCD file, or xxx = "PCD" for a PCD file, or xxx = "CAL" for a calibration file, or xxx = "MTA" for a metadata file, or xxx = "Rnn" for multiband-scene browse files where nn = 01–99 indicates the WRS scene sequence number within the subinterval, identified in the metadata file.	No Level 0R files are generated when no subintervals can be found in a contact period (probably containing extremely noisy data). The LPS operations learns about this problem from the Level 0R quality and accounting report for the processed contact period. The LPS Band 8 Level 0R processed data is split into up to 2 Gigabytes (GB) segments to meet the HDF maximum file size limitation.

Section 4 — LPS Output File Formats

4.1 LPS File Formats (HDF)

The EOSDIS project has selected the hierarchical data format (HDF) for exchanging data with external systems. The EOSDIS Project also uses the HDF for storing the received data in its active archives. The HDF supports standard data structures such as Vdata for storing various types of data. Applicable details on various data structures supported by the HDF are provided in Applicable Documents 5 and 10. The EOSDIS Project has also developed special HDF structures and a support library such as the HDF-EOS Swath for handling multiband remote sensing data collected by various satellites. The EOSDIS project has also adopted industry standards such as the Consultative Committee on Space Data Systems (CCSDS) Object Description Language/Parameter Value Language (ODL) for handling English text like data. Table 4-1 identifies the HDF-EOS object structures used by LPS in generating the Level 0R output files, the metadata file, and multiband-scene browse files.

4.1.1 Band Data File Format (HDF-EOS Swath)

4.1.1.1 Band Data File - Swath Format Overview

The LPS uses the HDF-EOS Swath structure for constructing band files. An LPS band file contains a single swath object. Each band data file contains a swath object consisting of a set of data fields, a set of geolocation fields, dimension information on each of the data and geolocation fields, and mapping of the geolocation fields to the data fields. Within the LPS band file swath context, the ETM+ instrument band-detector (scan line) data corresponds to the swath data field, and information about the band-detector data (e.g., spacecraft time, scan number, scan direction, and scan line number) correspond to the swath geolocation fields. The dimension information associates each geolocation field to data field (band array) dimensions (e.g., scanLineTrack). The WRS scene related geolocation fields, consisting of calculated "actual" scene center and corner latitudes and longitudes, are associated with the band data dimensions using a list of indices (index dimension). For a full length data scene, both the image (band) and ephemeris (PCD) data is expected to be available from the associated subinterval. Its "actual" scene center, expected in the proximity of the nominal WRS scene center, is computed from the actual PCD and indexed to actual data in the band file. For a partial scene with more than half a scene length data, the computed "actual" scene center is also expected to happen in the proximity of the nominal WRS scene center. The "actual" scene center for a greater than half a scene length partial scene may also be computed from the available actual PCD and indexed to actual data in the band file. For a partial scene with less than half a scene length data, the scene center may have to be computed from extrapolated ephemeris (no actual PCD may be available from the subinterval). The computed "imaginary" scene center for such a partial scene (less

Table 4-1: LPS Output Files - HDF Object Structures

LPS File	Applicable ETM+ Formats		File Contents (Note 1)	HDF Object Structure
Level 0R Files:				
Band 1 Image Data	1		Binary	Swath
Band 2 Image Data	1		Binary	"
Band 3 Image Data	1		Binary	"
Band 4 Image Data	1		Binary	"
Band 5 Image Data	1		Binary	"
Band 6 Image Data	1		Binary	"
Band 6 Image Data		2	Binary	Swath
Band 7 Image Data		2	Binary	"
Band 8 Image Data (1–3 segments, 1 file per segment, up to 2 GB each)		2	Binary	"
Mirror Scan Correction Data (MSCD)	1	2	Mixed	Point
Payload Correction Data	1	2	Mixed	Vdata
Calibration Data (Bands 1–6)	1		Binary	Swath
Calibration Data (Bands 6–8)		2	Binary	Swath
Level 0R Related Files:				
Metadata	1	2	ASCII Text	Object Description Language (ODL)
- Subinterval Level Metadata	1	2		
- WRS Scene Level Metadata	1	2		
- ACCA Results	1			
- Level 0R Q&A	1	2		
Multiband Scene Browse (one scene per file)	1		Binary	RIS24

Note 1: Applies to data and/or ancillary information formats only.

than half a scene) is still determined in the proximity of the nominal WRS scene center, but there will not be any actual band data in the subinterval band file to relate the scene center to. The computed "imaginary" scene center for a partial scene with less than half a scene length data is indexed to an "imaginary scan" (non-existent scan 0) in the band file. Figure 4-1 provides a structural overview of an HDF-EOS swath file/object for band data. Figure 4-2 provides an overview of the LPS band data organized under the HDF-EOS Swath structure. Tables 4-2 through 4-8 contain data, geolocation, and dimension details on the HDF-EOS Swath structure for constructing LPS band files.

An LPS band swath object consists of (band) swath data fields and (band) swath geolocation fields. Data fields in a band swath contain a contiguous set of scan data lines from a selected ETM+ band. Geolocation fields provide identification and data quality and accounting information for each scan data line in the band swath. A dimension map provides the linkage between geolocation fields and their associated scan data lines. Geolocation values for each scan data line in a band swath are provided. An index map provides selected mapping between geolocation fields and scan data lines. This mapping is used to provide scene center and corner reference points (scan data line locations) in the band data swath.

4.1.1.2 Band Data File Volume(s)

The following assumptions and band data volume information are used in defining HDF-EOS swaths and attributes for LPS band files:

1. ETM+ scans per scene:
   - Nominal: 335 (received WRS scene without scans overlap)
   - Maximum: 375 (distribution WRS scene with scans overlap)

2. Scan data lines (nominal, without scans overlap) per scene:
   - Bands 1–5 and 7: 335 x 16 = 5,360
   - Band 6: 335 x 8 = 2,680
   - Band 8: 335 x 32 = 10,720

3. Scan data lines (maximum, with scans overlap) per scene:
   - Bands 1–5 and 7: 375 x 16 = 6,000
   - Band 6: 375 x 8 = 3,000
   - Band 8: 375 x 32 = 12,000

4. Subinterval duration: ~14 minutes (maximum)
   (longest possible contact period duration)

5. Scene duration: ~ 24 seconds

6. Number of scenes per subinterval: ~ 35 (maximum)
   (longest possible contact period with a single subinterval)

7. ETM+ scans per subinterval:
   Nominal: 335 x 35 = 11,725

8. Scan data lines (maximum) per subinterval (scans do not overlap):
   - Bands 1–5 and 7: 5,360 x 35 = 187,600
   - Band 6: 2,680 x 35 = 93,800
   - Band 8: 10,720 x 35 = 375,200
   - Band 8: 10,720 x 35/4 = 93,800 (maximum possible in a file segment)

9. Active scan data line lengths (nominal):
   - Bands 1–5 and 7: 6313 Bytes [6320-7 for timecode and line sync code]
   - Band 6: 6320/2 = 3160 Bytes [no timecode and line sync code]
   - Band 8: 6313 x 2: 12,626 Bytes

10. LHS margins: bumper wear + extra/error
    - Bands 1–5 and 7: 17 + 23 = 40 Bytes
    - Band 6: 40/2 = 20 Bytes (margin is half of the margin for Bands 1–5 and 7)
    - Band 8: 40 x 2 = 80 Bytes (margin is double of the margin for Bands 1–5 and 7)

11. RHS margins: alignment space + bumper wear + extra/error
    - Bands 1–5 and 7: 213 + 17 + 17 = 247 Bytes
    - Band 6: 240/2 = 120 Bytes (margin is half of the margin for Bands 1–5 and 7 plus timecode and line sync difference)
    - Band 8: 247 x 2 = 494 Bytes (margin is double of the margin for Bands 1–5 and 7)

12. Band data line lengths (maximum):
    (nominal length + LHS margins + RHS margin)
    - Bands 1–5 and 7: 6,313 + 40 + 247 = 6,600 Bytes
    - Band 6: 3,160 + 20 + 120 = 3,300 Bytes (or 6,600/2 = 3,300)
    - Band 8: 12,626 + 80 + 494 = 13,200 Bytes (or 6,600 x 2 = 13,200)

13. Subinterval band data file volumes (maximum):
    - Bands 1–5 and 7: 187,600 x 6,600 = ~ 1.238 GB
    - Band 6: 93,800 x 3,300 = ~0.310 GB
    - Band 8: 375,200 x 13,200 = ~4.953 GB (all segments)
    - HDF File Size Limit = 2 GB (maximum)
    - Band 8 Segments: 4.953 / 2 = ~2.476 (or 3 maximum)
    - Band 8 Segment Size in LPS = up to 2 GB

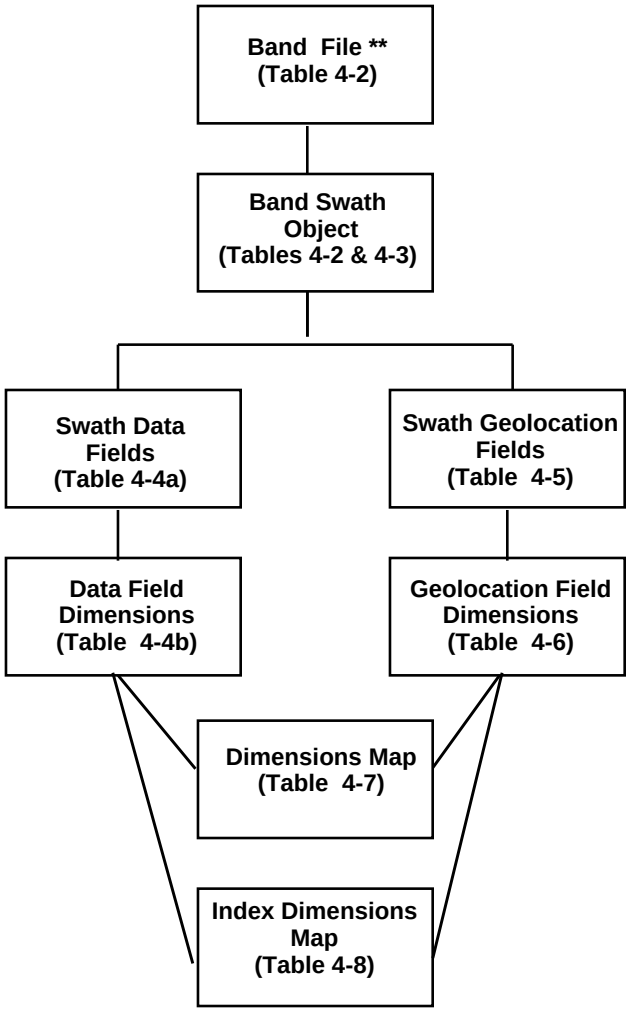
4.1.1.3 Band Fill Data

The LPS uses two values to fill VCDU minor frames to distinguish missing/bad band data from good data. The two values are placed as follows:

Odd detectors: fill with a pattern of 0's (00000000)

Even detectors: fill with a pattern of 255's (11111111)

This will be done on a minor frame basis - that is, if data is missing from part of a minor frame the whole minor frame will be filled. This fill pattern will not be operator adjustable through the user interface. Note that scan alignment fill data at the beginning and end of a scan will be all 0's. This is margin data and other data used for the integer-pixel alignment.



**** Six band files for Format 1 and 3-6 band files for Format 2 subinterval are generated.**

Swath File Definition and Structure

Figure 4-1: Band Data File - HDF-EOS Swath Structure

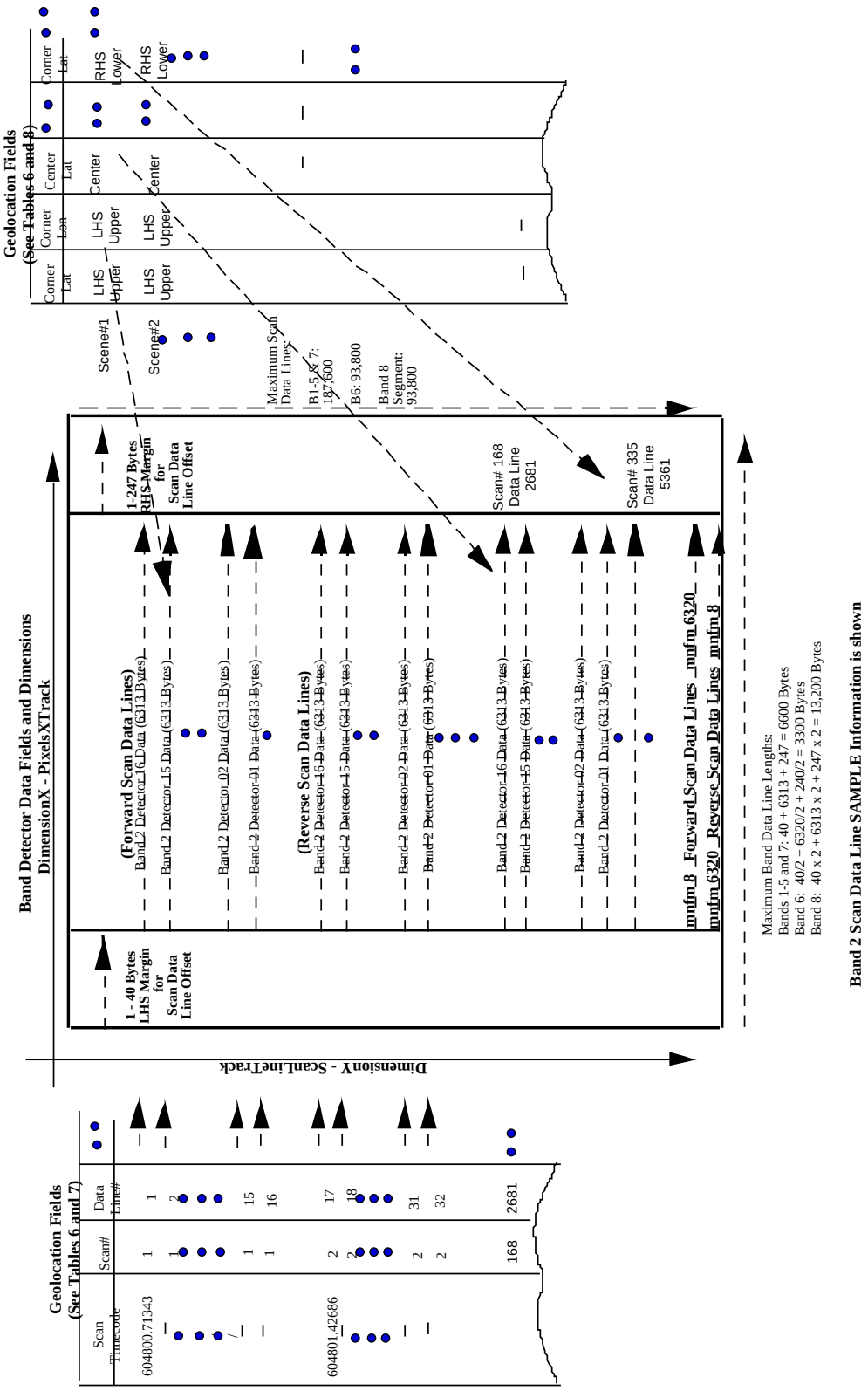


Figure 4-2: Band Data File - ECS-HDF Swath Overview

Table 4-2: Band Data File - Swath Object Definition Parameters

Swath Definition Parameter	Number Type and (Size)	Value, Format, Range and Unit	Parameter Description / Remarks
file_name	char8 (22)	= L7XsssfnYYDOYHHuuv.xxx where xxx indicates the band file identification details.	See Section 3.4 for complete details on the LPS file naming convention.
swath_name	char8 (6)	= Band_Swath_Bis where "Band_Swath_" identifies a L7 band data HDF-EOS swath object. One band swath object is produced for each ETM+ band, except Band 8. Up to three band swath objects, one each for Band 8 file segment and up to 2 GB in size, may be produced by LPS. Each band swath object is stored in a separate band swath file. Bis identifies ETM+ Format 1 and Format 2 band (image) data source bands as follows: Bi = B1–B8 for ETM+ Bands 1–8 s = 0 for single segment swaths for Bands 1–6 s = 1–3 for Band 8 segments (swaths).	Defined in accordance the xxx = "Bis" subset in the LPS file naming convention. See Section 3.4 for deriving the band file identification (Bis) details from the band data. Format 1 band data swath names: = Band_Swath_B10 = Band_Swath_B20 = Band_Swath_B30 = Band_Swath_B40 = Band_Swath_B50 = Band_Swath_B60 Format 2 band data swath names: = Band_Swath_B60 = Band_Swath_B70 = Band_Swath_B81 = Band_Swath_B82 = Band_Swath_B83 One band swath file contains one swath object.

Table 4-3: Band Data File - Swath Object Attributes

Attribute Name	Number Type (ntype)	Count	Attribute Values	Remarks
detector_count	int8	1	= 16 for Bands 1–5 and 7, = 8 for Band 6, and = 32 for Band 8	The detector_count value, selected for a band is fixed for the whole band file.
scene_count	int8	1	= 1–99 (full and/or partial) WRS scenes determined by LPS during Level 0R processing.	A maximum of 35 full scenes are expected in a 14-minute subinterval.

Table 4-4a: Band Data File - HDF Swath Data Field

Data Field Name	Type	Count	Values	Remarks
band_detector_data	uint8	= 6,600 for Bands 1-5 and 7 = 3,300 for Band 6 = 13,200 for band 8 (segments)	= 0 - 255 (grayscale/pixel data)	Band data is extracted, in minor frame order, from a single detector to form a scan line. All detectors of a band are used, in sequential order, to form all scan data line of a band in a scan. Table 4--3 provides the detector count for each ETM+ band. Section 4.1.1.2 lists the total number of scans and scan data lines contained in each band swath object. Band 8 is split into 1-3 segments (files). Each Band 8 segment file contains swath object for a Band 8 segment.

Table 4-4b: Band Data File - HDF Swath Data Field Dimensions

Data Field Name	Number Type	Cross-Track Dimension Name and Size	Track Dimension Name and Size	Merge Code
band_detector_data	uint8	Name: PixelsXTrack Size: = 6,600 for Bands 1–5 and 7 = 3,300 for Band 6 = 13,200 for each Band 8 segment	Name: ScanLineTrack Size: 1–11,725 scans* x detector_count or = 1–187,600 for Bands 1–5 & 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8 (1–93,800 scan lines per Band 8 file segment) *Without scene overlaps	=HDFE_NOMERGE (0) (no merge) There is only one band_detector_ data field in a single swath in a subinterval band file.

Table 4-5: Band Data File - HDF Swath Geolocation Fields

Geolocation Field Name	Number Type	Count	Value	Remarks
scan_timecode	char8	25	Scan line time of the form 'YYYY:ddd:hh:mm:ss.tttttt' where YYYY: Four-digit Julian year ddd: Day (01 through 366**) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) tttttt: fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) ** For cases when active imaging occurs at the end of a leap year.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame data reported in this record. A computed scan start time is provided if a valid time is not available from the ETM+ time code minor frames.
Time	float64	1	The ETM+ scan time in seconds since midnight on January 1, 1993, rounded to 7 decimal places.	The scan time is obtained by converting the scan_timecode (see below) to seconds. The ECS Project/HDF requires scan times in the seconds format and with the field name 'Time' to search data archives.
scan_no	uint16	1	scan_no = 1–11,725 The maximum scan count is based on a subinterval duration of 14 minutes for 35 scenes, each consisting of 335 scans. (See Section 4.1.1.2)	Provides a sequence counter for ETM+ scans (major frames) contained in a subinterval. The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the subinterval file.
scan_data_line_no	uint32	1	scan_data_line_no = SSSSSS where SSSSSS = 1–187,600 for Bands 1–5 and 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8 Note: The Band 8 scan data line count is not reset between segments (1–3).	The scan line counter is incremented for each Band-Detector data line added to the subinterval band file. There are 16 scan data lines each for Bands 1–5 and 7, 8 for Band 6, and 32 for Band 8 in each ETM+ scan. The maximum line counts are shown for a 14-minute subinterval (35 scenes).

Geolocation Field Name	Number Type	Count	Value	Remarks
scan_dir	char8	1	Scan direction character 'F' = Forward scan 'R' = Reverse scan 'U' = Unknown scan direction	The current ETM+ scan direction information obtained directly from the word 5, bit 1 of the PCD/Status data for the current scan. A valid ETM+ major frame has no errors. The default Forward direction will be used as the scan direction for the scan for the purpose of placing the data if the direction is unknown.
detector_id	uint8	1	where the detector_id is in the range: = 1–16 for Bands 1–5 and 7 = 1–8 detectors for Band 6 = 1–32 for Band 8	Each scan line in a band file consists of pixel data (bytes) from a single detector of a single band (see Figure 4-2). Each detector, chosen in a descending ID order, is used once during each scan for generating a scan line.
scan_data_line_ offset_rhs	int16	1	= 0–287 bytes for Bands 1–5 and 7 = 0–140 bytes for Band 6 (Format 1) and 6H (Format 2) = 0–574 bytes for Band 8 The scan line data may be shifted to right in the band data buffer after an integer-pixel alignment. The maximum value in the above ranges represents the sum of the rhs plus lhs offsets before bumper wear.	The scan line data in each record of the band file is initially written with a predetermined size of byte offset on the left and right of the designated scan line data area with a pattern of zeros. During integer-pixel alignment, these offsets provide moving in space (to avoid data loss) for the right-shifted band-detector data. After an integer-pixel alignment, this field indicates the resulting start and stop bytes/pixel positions for scan lines. This offset also accommodates scan line length growths due to ETM+ scanner bumper wear. (See Figure 4-2)
scan_data_line_ offset_lhs	int16	1	= 0–287 bytes for Bands 1–5 and 7 = 0–140 for Band 6 = 0–574 for Band 8 The scan line data may be shifted to left in the band data buffer after an integer-pixel alignment.	Note: The left-hand-side offset is not as significant as the right-hand-side margin. It can accommodate scan line length growths due to ETM+ scanner bumper wear. (See Figure 4-2) This value is dependent on values in the calibration parameter file.

Geolocation Field Name	Number Type	Count	Value	Remarks
scene_center_ latitude	float32	1	= -90.0 to +90.0 degrees A positive (+) value indicates a North latitude. A negative (-) value indicates a South latitude.	WRS Scene Center Latitude - LPS calculated "actual" center. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the band file.
scene_center_ longitude	float32	1	= -180.0 to +180.0 degrees A positive value (+) indicates a East longitude. A negative (-) value indicates a West longitude .	WRS Scene Center Longitude at LPS calculated "true center". Latitude and longitude values are calculated for WRS scenes that contain 375 scans (335 + 40 overlap scans). The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the band file.

Geolocation Field Name	Number Type	Count	Value	Remarks
Latitude	float32 array ul ur ll lr	2	= -90.0 to +90.0 degrees for each value of the array. A positive (+) value defines a latitude to the North. A negative (-) value defines a latitude to the South.	The Latitude geolocation field is made up of WRS scene upper-left (ul), upper-right (ur), lower-left (ll), and lower-right (lr) corner "actual" latitudes for a full or a partial scene. It is made up of a 2x2 array of values for each scene. The ECS Project/HDF requires latitudes in this array format and with the field name 'Latitude' to search data archives.
Longitude	float32 array ul ur ll lr	2	= -180.0 to +180.0 degrees for each value of the array. A positive value (+) defines a longitude to the East. A negative (-) value defines a longitude to the West.	The Longitude geolocation field is made up of WRS scene upper-left (ul), upper-right (ur), lower-left (ll), and , lower-right (lr) corner "actual" longitudes for a full or a partial scene. It is made up of a 2x2 array of values for each scene. The ECS Project/HDF requires longitudes in this array format and with the field name 'Longitude' to search data archives.

Table 4-6: Band Data File - HDF Swath Geolocation Field Dimensions

Geolocation Field Name	Number Type	Track Dimension Name and Size	Merge Code
scan_timecode	char8	Name: ScanLineTrack Size: 1–11,725	= HDFE_ AUTOMERGE (1) (OK to merge fields with shared dimensions and/or data type)
Time	float64	Name: ScanLineTrack Size: 1–11,725	= HDFE_ AUTOMERGE (1) (merge)
scan_no	uint16	Name: ScanLineTrack Size: 1–11,725	= HDFE_ AUTOMERGE (1) (merge)
scan_data_line_no	uint32	Name: ScanLineTrack Size: 1–11,725 x detector_count for selected band (See Table 4-3)	= HDFE_ AUTOMERGE (1) (merge)
scan_dir	char8	Name: ScanLineTrack Size: 1–11,725	= HDFE_ AUTOMERGE (1) (merge)
detector_id	uint8	Name: ScanLineTrack Size: 1–11,725 x detector_count for selected band (See Table 4-3)	= HDFE_ AUTOMERGE (1) (merge)
scan_data_line_offset_ rhs	int16	Name: ScanLineTrack Size: 1–11,725 x detector_count for selected band (See Table 4-3)	= HDFE_ AUTOMERGE (1) (merge)
scan_data_line_offset_ lhs	int16	Name: ScanLineTrack Size: 1–11,725 x detector_count for selected band (See Table 4-3)	= HDFE_ AUTOMERGE (1) (merge)
scene_center_latitude	float32	Name: CenterTrack Size: 1–scene_count (See Table 4-3)	= HDFE_ AUTOMERGE (1) (merge)
scene_center_ longitude	float32	Name: CenterTrack Size: 1–scene_count	= HDFE_ AUTOMERGE (1) (merge)

Geolocation Field Name	Number Type	Track Dimension Name and Size	Merge Code
Latitude	float32 array (2x2 per scene)	Name: GeoTrack, GeoXtrack Size: 2–2*scene_count, 2	= HDFE_ AUTOMERGE (1) (merge)
Longitude	float32 array (2x2 per scene)	Name: GeoTrack, GeoXtrack Size: 2–2*scene_count, 2	= HDFE_ AUTOMERGE (1) (merge)

Note: The terms "scan "and "Scan (Data) Line" provide two different views of the ETM+ data. A Scan (Data) Line is a subgroup of an ETM+ scan. These terms are defined as follows:

Scan: A scan results from a cross-track motion of the ETM+ instrument and consists of detector-sensed data from all bands. ETM+ Bands 1 through 5 and 7 produce 16 detector data lines each during each scan. Bands 6 and 8 produce 8 and 32 detector data lines, respectively, during each ETM+ scan.

Scan (Data) Line: A scan line is an image data line which is produced from a single detector of a band during a scan.

The geolocation fields (e.g. scan_no, Time and scan_data_line_no) associated with scan and scan data line are expected to lie along the same dimension (ScanLineTrack), except that they may occur at different increments and/or offsets.

Table 4-7: Band Data File - HDF Swath Dimension Map

Geolocation Dimension Name	Data Dimension Name	Offset	Increment
TimecodeTrack	ScanLineTrack	= 0 The timecode starts with the first scan line.	= detector_count The timecode repeats at detector count intervals.
TimeTrack	ScanLineTrack	= 0	= detector_count
ScanTrack	ScanLineTrack	= 0	= detector_count
ScanLineNoTrack	ScanLineTrack	= 0	= 1
ScanDirTrack	ScanLineTrack	= 0	= detector_count
DetectorIdTrack	ScanLineTrack	= 0 The detector ID starts with the first scan line.	= 1 The detector ID repeats on a scan line basis.
LhsOffsetTrack	ScanLineTrack	= 0 The left-hand-side offset starts with the first scan line.	= 1 A left-hand-side offset is present for each scan line.
RhsOffsetTrack	ScanLineTrack	= 0	= 1

Table 4-8: Band Data File - HDF Swath Index Dimension Map

Geolocation Dimension Name	Data Dimension Name	Index (array size) (Indices of Data Dimension)	Remarks
CenterTrack	ScanLineTrack	CenterScanLine (scene_count) (Ref. Table 4-3)	Each scene center is associated with a unique/single scan line in a band file except for partial scenes. Centers for partial scenes may lie outside the sub-interval. In this case the scene center is not associated with a scan line.
GeoTrack	ScanLineTrack	GeoIndex (2*scene_count)	Each corner (for both longitude and latitude) is associated with a specific scan line in the band file to distinguish their upper and lower corner positions. Note that data index mapping counts starting from 0.
GeoXtrack	PixelsXTrack	2	Used to index from left to right in Longitude and Latitude geolocation fields.
UpperTrack	ScanLineTrack	UpperScanLine (scene_count)	Each corner is associated with a specific scan line in the band file to identify it's upper and lower corner positions. This is needed for internal LPS processing.
LowerTrack	ScanLine Track	LowerScanLine	(See UpperTrack)

4.1.2 MSCD File Format (HDF-EOS Point)

4.1.2.1 MSCD File Description

The LPS generates an MSCD file for each ETM+ format: Format 1 and Format 2. The LPS uses the HDF-EOS Point structure for generating an MSCD file. Table 4-9 defines the HDF-EOS Point structure for the LPS MSCD file. The MSCD file name follows the file naming convention of Section 3.4. It is not included in the MSCD file itself.

The MSCD file is organized by ETM+ scans. The spacecraft time associated with each ETM+ scan is provided in seconds since January 1, 1993. This spacecraft time is also provided in the Julian day of year and time format.

The MSCD file format is designed to be neutral to ETM+ Format 1 or Format 2 data. The LPS should produce mirror copies of the MSCD file for both formats if they are received with the same MSCD minor frame words with same errors.

4.1.2.2 MSCD Fill Values

Under noisy data input and poor CADU/VCDU and ETM+ data synchronization conditions, the values for most MSCD fields are expected to be generated through flywheel and/or computation processing. MSCD fields "scan_no" and "Time" are examples of such fields. They can always be determined even if a major frame is entirely filled. However, some MSCD fields will require the use of a fill pattern and/or flags to indicate that correct values could not be determined due to an entirely filled ETM+ major frame. Such MSCD fields include: "gain_status", "mux_assembly_id" and "cal_shutter_status" fields. The fill and/or flag values for these fields are included with their specifications in the MSCD file format (Table 4-9). Other fields will be filled with a value of 0. These are the "eol_location," "fhs_vote," "fhs_err," "shs_vote," "shs_err," "cadu_sync," "scan_sync," "cadus/vcdus_received," "fly_wheel_cadus," "bit_slip_cadus," "r-s_err_cadus," "bch_corrected_vcdus, " "bch_uncorrected_vcdus, " and "minf_filled" fields.

Table 4-9: MSCD File - HDF Vdata Definition and Fields

HDF-EOS Point Name: LPS_MSCD	
Point Level: MSCD	
Bytes Per Logical Record: 85	(Excluding HDF overhead) Maximum File Size = 0.95 MB for a 14-minute subinterval (11,728 major frames)
Number of Records: One record per ETM+ scan (major frame)	

Field Name	Number Type	Order	Description	Remarks
scan_no	uint16	1	Subinterval scan counter = 1 - 11725 where, the maximum scan count of 11,725 is based on a maximum subinterval duration of 14 minutes for 35 scenes, each consisting of 335 scans; The MSCD file may not be generated if the total number of scans received in a subinterval are less than an operator selectable number (parameter).	Provides a sequence counter for the ETM+ scans (major frames) contained in a subinterval. The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the subinterval file. An LPS-produced subinterval can contain data for a partial WRS scene (less than 335 scans).
Time	float64	1	The ETM+ scan time in seconds since midnight on January 1, 1993, rounded to 7 decimal places.	The scan time is obtained by converting the scan_timecode (see below) to seconds. The ECS Project requires scan times in the seconds format and with the field name 'Time' to search data archives.
scan_timecode	char8	25	Scan line time of the form 'YYYY:ddd:hh:mm:ss.tttttt' where YYYY: four-digit Julian year ddd: day (01– 366**) hh: hours (00–23) mm: minutes (00–59) ss: seconds (00–59) tttttt: fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) ** For cases when active imaging occurs at the end of a leap year.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame data reported in this record. A computed scan start time is provided if a valid time is not available from the ETM+ time code minor frames. This time is expressed in Greenwich Mean Time (GMT) standard. (**Note - The ECS does not use this timecode.)

Field Name	Number Type	Order	Description	Remarks
timecode_flag	uint8	1	Valid timecode flag: 0 = valid timecode 1 = computed timecode	
eol_flag	uint8	1	Flag for valid end of line (EOL) pattern code: 0 = valid pattern in expected location (minor frame location) 1 = missing EOL - the EOL pattern is not found at all 2 = valid pattern found inside user specified range but outside nominal range	The presence of an EOL code is needed by LPS to start calibration data extraction. If there is a missing EOL the nominal scan line length will be assumed. This way the pixel data may be salvaged, but the flag is needed to warn users that it may be suspect. Calibration data, though, would need to be filled since there is no way of knowing just where that started. A user specified parameter gives the bilateral search zone around the nominal location for the EOL marker. The nominal range for the EOL marker is given in the eol_location field description.
eol_location	uint16	1	Minor frame location (number in the range: 6,318–6,323) The minor frame location (number) within a major frame that contains the first word of the ETM+ End of Line (EOL) code. The eol_flag reports eol_location errors.	The EOL is expected to occur within the vicinity of minor frame number 6,320 in each ETM+ major frame. The EOL code consists of two adjacent minor frames. The EOL indicates an end of the active scan period and start of a calibration data period past the scan line data (SLD) words. If eol_flag =1, LPS will supply the nominal location for eol_location.
scan_dir_vote	uint8	1	Scan direction majority vote quality 0 = all bits in all scan direction word groups are equal 1 = at least one bit in the scan direction word groups is not equal to the other bits 2 = the scan direction is not found for a missing and/or an entirely filled scan. It is interpolated from the previous scan.	A majority vote quality of 1 may indicate an error with the received and/or decoded scan direction value (back-to-back forward or reverse scans). See note after table.

Field Name	Number Type	Order	Description	Remarks
scan_dir	char8	1	Scan direction character 'F' = Forward scan 'R' = Reverse scan 'U' = Unknown scan direction	The ETM+ scan direction information is interpolated from the Scan Line Data (SLD) minor frames of the ETM+ major frame. The scan direction value reported here is for the **PREVIOUS** scan (ETM+ major frame). The default Forward direction will be used as scan direction for the purpose of placing the data if the direction is unknown.
fhs_vote	uint8	1	FHS error majority vote quality 0 = all bits in each FHS Error word group are equal 1 = at least one bit in at least one FHS Error word group is not equal to the other bits in the group	A value of '1' indicates that the received/decoded fhs_err value is probably erroneous.
fhs_err	int16	1	First half scan error count: - 2048 to + 2047 This is a 12-bit number provided in an int16 field using 2's complement notation. See the Landsat 7 DFCB (Applicable Document 2.1.4) for additional details.	The first half scan error (FHS ERR) is extracted from the Scan Line Data (SLD) minor frames of the ETM+ major frame. The FHS ERR value reported here is for the **PREVIOUS** scan (ETM+ major frame).
shs_vote	uint8	1	SHS error majority vote quality 0 = all bits in each SHS Error word group are equal 1 = at least one bit in at least one SHS Error word group is not equal to the other bits in the group	A value of "1" indicates that the received/decoded shs_err value is probably in error.
shs_err	int16	1	Second half scan error count: - 2048 to + 2047 This is a 12-bit number provided in an int16 field using 2's complement notation. See the Landsat 7 DFCB (Applicable Document 2.1.4) for additional details.	The second half scan error (SHS ERR) is interpolated from the Scan Line Data (SLD) field of the ETM+ major frame. The SHS ERR value reported here is for the **PREVIOUS** scan (ETM+ major frame).

Field Name	Number Type	Order	Description	Remarks
gain_status	char8	9	= gggggggggg where g indicates band positions 123456678 for the Format 1 and Format 2 band gain status. Band position subsets 123456 and 678 are associated with Format 1 and Format 2 bands, respectively. g = L in a band position indicates a low gain g = H in a band position indicates a high gain. g = Ns in all band positions indicate that gain values could not be found due to an entirely filled major frame.	For each band, the gain status is defined by the gain state value contained in the "PCD/Status Data" field of the first error-free VCDU of the ETM+ major frame. The gain_status values for all ETM+ bands are provided in both Format 1 and Format 2 MSCD files.
gain_change	char8	9	= gggggggggg where g indicates band positions 123456678 for the Format 1 and Format 2 bands gain changes. Band position subsets 123456 and 678 are associated with Format 1 and Format 2 band gain changes, respectively. g = 0 in a band position indicates no gain change, i.e., the gain_status of the previous scan is equal to the gain_status of this scan OR no band gains changed due to an entirely filled major frame. g = + in a band position indicates a gain change from low to high g = - in a band position indicates a gain change from high to low	The gain_change values in the first scan should be set to all "0s" because the previous scan required for the band gain change comparisons does not exist. The gain_change values for all ETM+ bands are provided in both Format 1 and Format 2 MSCD files.
mux_assembly_ id	uint8	1	= 0–7 for Landsat 7 multiplexer assemblies 0–7 OR = 9 to indicate that the mux_assembly_id value could not be extracted from an entirely filled major frame.	Identifies the Landsat 7 spacecraft on-board multiplexer used in the ETM+ data flow for this major frame. The multiplexer status is obtained from the first error-free CADU/VCDU used in the construction of this major frame.
cal_shutter_ status	uint8	1	0 = CAL shutter 1 = Backup shutter OR = 9 to indicate that the cal_shutter_status value could not be extracted from an entirely filled major frame.	Identifies the Landsat 7 spacecraft on-board CAL shutter status during the ETM+ data flow for this major frame. The CAL shutter status is obtained from the first error-free CADU/VCDU used in the construction of this major frame.

Field Name	Number Type	Order	Description	Remarks
cadu_sync	uint8	1	Flag to indicate loss of CADU sync anywhere within the scan: 0 = no loss 1 = sync loss	A sync loss condition indicates potential loss of minor frame data requiring LPS to use fill data in completing a major frame (ETM + Scan).
scan_sync	uint8	1	Flag for valid sync for current major frame: 0 = valid sync 1 = flywheeled sync	Valid sync: The line sync code was correctly found and decoded as specified in the Landsat 7 DFCB. Flywheeled sync: The sync in the current scan is forced "True" because line sync code minor frame could not be found and/or correctly decoded as specified in the Landsat 7 DFCB. The presence of the Line Sync Code is "deduced" from correctly finding/decoding the Time Code minor frames of the current ETM+ major frame or the next scan sync.
minf_faults	char8	1	An index (hexadecimal 0 through D) representing the number of minor frame faults (m) in the range: '0' = no faulty minor frames '1' = 1 ≤ m ≤2 '2' = 3≤ m ≤ 4 '3' = 5≤ m ≤ 8 '4' = 9 ≤ m ≤ 16 '5' = 17 ≤ m ≤ 32 '6' = 33 ≤ m ≤ 64 '7' = 65 ≤ m ≤ 128 '8' = 129 ≤ m ≤ 256 '9' = 257 ≤ m ≤ 512 'A' = 513 ≤ m≤ 1024 'B' = 1025 ≤ m ≤ 2048 'C' = 2049 ≤ m ≤ 4096 'D' = 4097 ≤ m ≤ NNNN 'E' = Not Applicable 'F' = Not Applicable NNNN is an LPS operator-selectable parameter for the maximum number of minor frames possible in an ETM+ major frame.	This quality index is computed by LPS on a major frame basis. This index provides a quick-look assessment on the number of faulty minor frames contained in a major frame. Faulty minor frames contain fill data or are extracted from VCDUs containing uncorrected BCH errors. Lower quality indices indicate better quality major frames. Without bumper wear, there are a nominal of 7,423* minor frames in an ETM+ major frame. Accounting for 17** minor frames of bumper wear on each end of the scanner, there could be a maximum of 7,457 minor frames in an ETM+ major frame. * Source: Landsat 7 DFCB Table 7 (Applicable Document 2.1.4) ** LPS design assumption and a parameter.
cadus/vcdus_ received	uint16	1	= 0–650 (decimal) Approximately 643 VCDUs are required to build one ETM+ major frame (consisting of approximately 7,423 minor frames).	The total number of unfilled (good) VCDUs used in the construction of this ETM+ major frame.

Field Name	Number Type	Order	Description	Remarks
fly_wheel_cadus	uint16	1	= 0–650	The total number of flywheel CADUs/VCDUs in this ETM+ major frame.
bit_slip_cadus	uint16	1	= 0–650	The total number of CADUs/VCDUs detected with bit slip errors in this ETM+ major frame.
r-s_err_vcdus	uint16	1	= 0–650	The total number of VCDUs with uncorrected Reed-Solomon errors used in the construction of this ETM+ major frame.
bch_corrected_ vcdus	uint16	1	= 0–650	The total number of VCDUs, containing corrected BCH errors, in this major frame.
bch_uncorrected _vcdus	uint16	1	= 0–650	The total number of VCDUs, containing uncorrected BCH errors, in this major frame.
filled_scan_flag	uint8	1	0 = no fill data used in this scan 1 = entirely filled scan 2 = partially filled scan	This flag indicates if any predetermined fill data was used in the construction of this ETM+ scan (major frame). There are a nominal 7,423 minor frames in a scan.
minf_filled	uint16	1	0–7500	The total number of filled minor frames in this ETM+ major frame. There are a nominal of 7,423 minor frames in a scan.

Note: ASCII values are enclosed in single quotes (e.g., '1' = ASCII one). Additional information for scan_dir_vote: Scan direction is determined by eight 5-word groups in the telemetry. Currently, if all eight 5-word groups do not resolve to the same value of 0 or 1 for the scan direction, the LPS determines the scan direction from the previous major frame scan direction by interpolation. If there is no previous scan direction available, the LPS will use the single bit values condensed from each group for a simple majority vote to obtain the scan direction. This process will ignore groups which do not condense into a 0 or a 1. The scan_dir_vote field will be set as 1 in this case. If the majority vote does not produce a 0 or 1 solution, then the direction for placing the pixels will be chosen as Forward for MSCD. The scan_dir field will have the value of 'U' for unknown, though, and the scan_dir_vote field will have the value of 2.

4.1.3 PCD File Format (HDF Vdata)

4.1.3.1 PCD File Description

This section presents a detailed format of the LPS output PCD file. The LPS generates separate PCD files for the ETM+ Format 1 and Format 2 data during Level 0R processing. The PCD items contained in this file are converted to the engineering units (EUs) identified in the Landsat 7 DFCB. The LPS uses the HDF Vdata structure for producing LPS output PCD files. Table 4-10 defines the HDF Vdata structure for the LPS output file containing PCD data engineering units for the ETM+ Format 1 and Format 2 data.

The LPS output PCD file uses a single/common Vdata structure for reporting each of the major frames received in a PCD cycle. Each PCD major frame is uniquely identified by its associated spacecraft time. This spacecraft time, which is extracted and/or computed from the raw input PCD data, is provided in two different engineering units. The first engineering unit presents the spacecraft time in the Julian day of year and time format. The second engineering unit presents the spacecraft time of a PCD major frame time in seconds since January 1, 1993. The time-in-seconds engineering units format is provided by the LPS to comply with the ECS project requirement for a searchable time Vdata type in units of seconds.

4.1.3.2 PCD Fill Data

The LPS puts a PCD fill value in the output PCD file fields (Table 4-10) when they cannot be correctly constructed, computed, interpolated and/or flywheeled from the available unpacked PCD words and minor frames in a PCD major frame.

In general the LPS uses a default value of "-1" for signed number (data) types, maximum values for unsigned number types and the dollar sign "$" character for "char8," but this does not cover all fields. The fill data values for each field are either specified individually or in the group description. The fields cycle_count and majf_count are always calculated and so do not have fill values.

Table 4-10: PCD File - HDF Vdata Definition and Fields

Vdata Name: L7XsssfnYYDOYHHuuv.xxx	where xxx = "PCD" for the PCD file Complete details on the LPS file-naming convention are specified in Section 3.4. There are 179 fields in the PCD file.
Vdata Class: LPS_PCD	
Interlace Type: FULL_INTERLACE	
Bytes Per Logical Record: 26,512	(Excludes HDF overhead)* Maximum file size = ~5.43 MB for a 14-minute subinterval (205 PCD major frames)
Number of Records: One record per PCD major frame (4.096 spacecraft seconds)	

Field Name	Number Type	Order	Description	Remarks
PCD Major Frame Identification Data *(not a Vdata table attribute/entry)*	-	-	*A new PCD major frame is inserted in the PCD file every 4.096 seconds of the spacecraft time.* *All PCD data are presented in their respective engineering units (EUs) as noted in the Landsat 7 DFCB.*	*One full PCD major frame consisting of a maximum of 128 minor frames, each containing 128 8-bit words (total 16,384 bytes) is included in each PCD record. No PCD bytes, valid or not, are dropped by LPS. See Landsat 7 DFCB for details on PCD words/bytes.*
cycle_count	uint8	1	PCD cycle number (00–99) There are approximately 52 PCD cycles in a 14-minute subinterval.	The PCD cycle number associated with PCD major frame reported in this record of the PCD file. A PCD cycle consists of a set of 4 consecutive PCD major frames: (0), (1), (2), and (3). This number is incremented by 1 for each PCD major frame (0) (identified by spacecraft ID and timecode in words 72 of minor frames 96–102) received in the ETM+ subinterval.
majf_count	uint8	1	PCD major frame counter value (001–255) There could be approximately 206 PCD major frames in a 14-minute subinterval (PCD major frame time = 4.096 seconds).	The major frame counter value of the PCD major frame reported in this record of the subinterval PCD file. The PCD major frame number is incremented by one for each new PCD major frame added to this file.

Field Name	Number Type	Order	Description	Remarks
majf_id	uint8	1	PCD major frame ID (0–3) The PCD major frame ID with a simple majority vote of 5 out of 8 bytes should be considered the prevailing value. Fill value = 255.	The PCD major frame ID is determined by the information contained in word 72, minor frames 96–103 (8 bytes) of each PCD major frame contained in a PCD cycle. PCD major frame (0) is identified by the presence of spacecraft ID and timecode information in the word 72 locations. Other PCD major frames are identified by their ID numbers (1–3).
majf_time	float64	1	PCD major frame time in seconds since January 1, 1993, rounded to 7 decimal places. Fill value = -10.	This time is the PCD major frame time (majf_timecode; see next entry) converted by LPS to seconds since January 1, 1993.
scan_timecode	char8	25	Scan line time of the form 'YYYY:ddd:hh:mm:ss.tttttt' where YYYY: four-digit Julian year ddd = day (01 through 366**) hh = hours (00–23) mm = minutes (00–59) ss = seconds (00–59) tttttt: fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) Fill value = $$$$... ** For cases when active imaging occurs at the end of a leap year.	For PCD major frame (0), the spacecraft time is extracted from PCD Major frame (0) of a PCD cycle. For PCD major frames 1–3, the spacecraft timecode is interpolated using the spacecraft time received for PCD major frame (0) of the associated PCD cycle. Fill value occurs at the beginning of the PCD file when there has not yet been a valid major frame (0) or if there is a missing cycle.
Selected PCD Items ***(not a Vdata table attribute/entry)***	-	-		
band_states	char8	8	Indicates ETM+ bands on/off states for Format 1 and Format 2 data. = 12345678 for all bands in "ON" state for Format 1 and Format 2 data. A "-" indicates an "OFF" state or a missing band (e.g., "123-5678" for Band 4 "OFF". Fill value = $$$$$$$$	This information is extracted from the third PCD major frame, minor frame 32, word 72, bits 0–6 and major frame 2, minor frame 35, word 72, bit 0.

Field Name	Number Type	Order	Description	Remarks
fac_flag	uint8	1	Full Aperture Calibration door flag: = 0 indicates no activity = 1 indicates calibration door activity (open and/or imaging) Fill value = 255.	ETM+ Calibration Activity Status. This status is interpolated from "serial word P" of the third PCD major frame, minor frame 84, word 72, bits 2 and 3.
PCD Major Frame Quality and Accounting Data ***(not a Vdata table attribute/entry)***	-	-	*Except for majf_flag and timecode_flag which have fill or missing indicators, for an entirely filled major frame the value of 0 should be used.*	*To maintain consistency with the Landsat 7 Wideband DFCB, the smallest PCD granule is called a "word". A PCD word = an 8-bit byte.*
unpacked_pcd_ words	uint32	1	= 0–147,497 unpacked PCD words received for this major frame.	Count of unpacked PCD words received for this PCD major frame.
unpacked_words_ missing	uint32	1	= 0–147,497 unpacked PCD words missing for this major frame.	Count of unpacked PCD words identified as missing due to missing VCDUs. Some received PCD major frames may contain LPS filled data.
vote_errors	uint16	1	= 0–16384 packed words in a PCD major frame.	Count of (packed) PCD major frame words found to contain voting errors during packing a PCD word/minor frame. Some PCD major frame words may contain erroneous or LPS filled data.
minf_sync_errors	uint8	1	= 0–128 (minor frames per major frame)	Count of PCD minor frames received with sync errors in this major frame. Some PCD words may be lost and filled due to minor frame sync errors.
minf_id_errors	uint8	1	= 0–128 (minor frames per major frame)	Count of PCD minor frames received with incorrect minor frame IDs (counter values). Corrected IDs are filled in.
minf_filled	uint8	1	= 0–128 (minor frames per major frame)	Count of PCD minor frames found with erroneous data in PCD words and filled by LPS with a known value.
majf_flag	uint8	1	PCD major frame flag where 0 = valid major frame ID 1= incorrect major frame ID; 2= missing major frame ID; Used for major frames (1), (2), and (3) only. If in error, the PCD major frame ID is corrected by LPS.	Indicates the quality of the PCD major frame ID found in word 72, minor frames 96–103 of PCD major frames (1), (2), and (3). PCD major frame (0) contains the timecode flag (see below).

Field Name	Number Type	Order	Description	Remarks
timecode_flag	uint8	1	Valid PCD timecode flag, where 0 = valid timecode and spacecraft ID 1 = computed timecode 2 = corrected spacecraft ID 3 = flags 1 and 2 combined 4 = fill value for timecode 5 = fill value for timecode and spacecraft ID	Indicates the quality of the spacecraft ID and timecode data contained in word 72, minor frames 96–103, of PCD major frames(0). For PCD major frames (1)–(3), the timecode flag is also interpolated /derived from the timecode flag used for major frame (0).
PCD Major Frame Data ***(not a Vdata table attribute/entry)***				
spacecraft_id	char8	1	spacecraft_id = "7"	The Landsat 7 spacecraft ID is determined from bytes 0–3 of PCD timecode word 96 located in major frame (0) of each PCD cycle. For the remaining three major frames in a PCD cycle, this spacecraft ID is copied for each major frame. The spacecraft ID is also forced to "7" when an erroneous ID is read or the spacecraft ID is missing. The spacecraft ID error is noted in the s/c_id_err_pcd field.
sv_clk_last_u/d_time	float64	1	sv_clk_last_u/d_time = 0–31,622,400 seconds from midnight of the first day of the current year. Fill value = -1.0 This time is presented as a double precision floating point number in HDF to accommodate the 48-bit extended precision floating point value/sample received in the PCD data.	See L7 DFCB Section 3.2.7.4.6 for details on the SV clock last update time.
time_drift_bias_c0	int16	1	Spacecraft time drift bias (C0) = +/- milliseconds Fill value = 7FFF	See L7 DFCB Section 3.2.7.4.7 for details on the SV (spacecraft) time drift characterization data.
time_drift_rate_c1	int16	1	Spacecraft clock drift rate (C1) = +/- milliseconds/day Fill value = 7FFF	See above
time_drift_ acceln_c2	int16	1	Spacecraft clock drift acceleration (C2) = +/- milliseconds/day^2 Fill value = 7FFF	See above

Field Name	Number Type	Order	Description	Remarks
ETM+ TLM @ 4.096 seconds rate ***(not a Vdata table attribute/entry)***	-	-	*Repeat the following PCD values for each PCD major frame. If a major frame does not contain the required PCD value, fill these with all ones (FF in hexadecimal for uint8, FFFF for uint16).*	*The following PCD values should be copied in the same format as found in their respective PCD words/minor frames in a PCD major frame.*
black_body_temp_iso	uint8	1	Black Body Temperature (Isolated)	See above
cfpa_heater_current	uint8	1	CFPA Heater Current	See above
cal__shutr_flag_temp	uint8	1	Calibration Shutter Flag Temperature	See above
b/u_shutr_flag temp	uint8	1	Backup Shutter Flag Temperature	See above
black_body_temp_con	uint8	1	Black Body Temperature (Control)	See above
baffle_temp_heater	uint8	1	Baffle Temperature (Heater)	See above
cfpa_control_temp	uint8	1	CFPA Control Temperature	See above
pdf_a/d_ground_ref	uint16	1	PDF A/D Ground Reference	See above
ETM+ TLM @16.384 seconds Rate ***(not a Vdata table attribute/entry)***	-	-	*Repeat the following PCD values for each PCD major frame. If a major frame does not contain the required PCD value, fill these with all ones (FF in hexadecimal).*	*The following PCD values should be copied in the same format as found in their respective PCD words/minor frames in a PCD major frame.*
serial_words_a_s	uint8	18	Serial Word "A" components: a, b, c, d, e, f, g, h, i, j, k, l, m, n, p, q, r, s	See above
mux1_elec_temp	uint8	1	Mux 1 Electronics Temperature	See above
mux1_ps_ temp	uint8	1	Mux 1 Power Supply Temperature	See above
mux2_elec_temp	uint8	1	Mux 2 Electronics Temperature	See above
mux2_ps_temp	uint8	1	Mux 2 Power Supply Temperature	See above
acs_cpu_mode	uint8	1	ACS CPU Mode	See above
etm_tlm_mnf_16_30	uint8	15	ETM TLM MF(2), mfs(16–30)	See above
etm_tlm_mnf_40_49	uint8	10	ETM TLM MF(2) mfs(40–49)	See above
etm+_on_time	float64	1	Time ETM+ was last on: etm+_on_time = 0–31,622,400 seconds from midnight of the first day of the current year. Reported for each PCD major frame (0) record. If a PCD major frame (1, 2, or 3) does not contain the required PCD value, use -1.0 as the fill value.	See L7 DFCB Sections 3.2.7.4.6 and 3.2.7.4.16 for details on this time. Reported as an HDF double precision floating point number to accommodate the 48-bit extended precision floating point value/sample received in major frame (0) of a PCD cycle.
etm+_off_time	float64	1	Time ETM+ was last off: See above for related description.	See above

Field Name	Number Type	Order	Description	Remarks
Ephemeris Data ***(not a Vdata table attribute/entry)***		-	*The ephemeris data, consisting of the position and velocity components, is available on a PCD major frame basis.*	*See L7 DFCB Section 3.2.7.4.8 for details on the ephemeris data.* *Note: The ephemeris data source minor frame locations change for odd and even numbered major frames (0–3).*
ephem_position_xyz	float64	3	Includes position components: x, y and z Position Range: +/- 8.3886 x 10^6 meters Fill value = 10^7	See above
ephem_velocity_xyz	float64	3	Includes velocity components: x, y and z Velocity Range: +/- 8.0 meters/milliseconds Fill value = 10	See above
Attitude Estimate ***(not a Vdata table attribute/entry)***	-	-		See Landsat 7 DFCB Section 3.2.7.4.5 for word/minor frame locations of attitude data in PCD major frames.
attitude_est_epa1234	float64	4	Attitude Euler parameters: EPA1, EPA2, EPA3 and EPA4 Fill value = 2	Same as above
gyro-select_data	Char8	1	= "A" for Gyro A selected, or = "B" for Gyro B selected, or = "-" to indicate a gyro select error (PCD minor frame 34 decoding error). A Gyro selection is valid (error free) when all three X, Y and Z axis associated with a selected gyro, A or B, are "True" ("1s" for Gyro A and "0s" for Gyro B. Fill value = $	Bits 0 - 2 of minor frame 34 in subcom word 72 of PCD major frame 0 identifies the Landsat 7 selected gyro, A or B. Bits 3 - 7 are ignored. Section 3.2.7.4.17 contains details on decoding the gyro selection data (status).

Field Name	Number Type	Order	Description	Remarks
Gyro (IMU Axes) Data ***(not a Vdata table attribute/entry)***	-	-	**Note:** The following IMU axes (x, y, z) readings are repeated 64 times in each major frame. The IMU axes values are in arc-seconds of angular motion. A total of 256 readings (samples) are collected for each PCD cycle. The Gyro data order is as follows: - all 64 roll values (Roll-1, Roll-2...) - all 64 pitch values (Pitch-1, Pitch-2...) - all 64 yaw values (Yaw-1, Yaw-2...) Fill values are MAXFLOAT	*See L7 DFCB Section 3.2.7.4.3 for details on gyro data. Each IMU axes counter value is first constructed by concatenating the three bytes for each axis (e.g., x1, x2, and x3) and then converting to arc-seconds. For converting the IMU counter values to engineering units, each increment or decrement in the 24-bit counter value of an IMU axes represent a 0.061 arc-second change.*
imu_roll_x00_x63	float64	64	= - 511705.088 to + 511705.027 arc-seconds for components x00 – x63 in the PCD major frame.	See above
imu_pitch_y00_y63	float64	64	= - 511705.088 to + 511705.027 arc-seconds for components y00 – y63 in the PCD major frame.	See above
imu_yaw_z00_z63	float64	64	= - 511705.088 to + 511705.027 arc-seconds for components z00 – z63 in the PCD major frame.	See above
Gyro Drift Data *(not a Vdata table attribute/entry)*		-	*Note: The Gyro drift data is reported once per PCD cycle in major frame (0) only.*	*See L7 DFCB Section 3.2.7.4.4 for details on the Gyro Drift data.*
gyro_drift_theta-xyz	float64	3	Includes components: x, y and z. The units of gyro drift (rate) data for each axis are in radians/512 milliseconds. Fill value = -1.0	The least significant bit weight of the theta value is adjusted to 2^{-47} before converting to engineering units.

Field Name	Number Type	Order	Description	Remarks
Angular Displacement Sensor Data (ADS) ***(not a Vdata table attribute/entry)***	-	-	***Note**: The following fields are repeated for each minor frame in the PCD major frame. The minor frame ID (mnfm_ids_000_127) is reported once for a total of 16 sets of ADS x, y, z values. The 16 sets of ADS x, y, z values are reported for each of the 128 minor frames in a PCD major frame.* *All ADS x, y, z measurements are converted to microradians and reported in ascending order of their source words and minor frames in a PCD major frame. All data is reported with single floating point precision.* *Fill value for all including mnfm_ids_000_127 is 255.*	*See L7 DFCB Section 3.2.7.4.1 for details on ADS data. A total of 16 ADS measurements, each consisting of the x,y and z components, are received in a PCD minor frame.*
mnfm_ids_000_127	uint8	128	Minor frame ID (counter) components: 000 - 127	The PCD minor frame counter value/ID from word location 65 of each minor frame. There are 128 (IDs: 000–127) minor frames in a PCD major frame.
ads_xyz16_mnfm_000	float32	48	x01, y01, z01, x02, y02, z02, ... x16, y16, z16	(See above)
ads_xyz16_mnfm_001	float32	48	x01, y01, z01, x02, y02, z02, ... x16, y16, z16	(See above)
• • •			A total of 16 sets of ads x, y, and z components are reported for each minor frame (000 - 127).	(See above)
ads_xyz16_mnfm_127	float32	48	x01, y01, z01, x02, y02, z02, ... x16, y16, z16	(See above)
ADS Temperatures ***(not a Vdata table attribute/entry)***	-	-	***Note**: The ADS x, y, z and A/D electronic temperature values are reported on a major frame basis. All temperatures are reported in degrees Centigrade (^{O}C).*	*See L7 DFCB Section 3.2.7.4.2 for details.*
ads_temp_xyz+a/d	float32	4	Includes temperature values for components: x, y, z and elec_a/d Fill value = 255	(See above)
PCD Quality and Accounting Data ***(not a Vdata table attribute/entry)***			The following PCD quality data is produced by LPS and appended to each major frame record of the PCD file.	

Field Name	Number Type	Order	Description	Remarks
s/c_id_err_pcd	char8	1	Spacecraft ID error in PCD: s/c_id_err_pcd = "n" for no errors "y" for errors detected in the spacecraft ID field	The error flag is true whenever the spacecraft ID is not equal to "7" and is corrected to "7".
att_data_quality	char8	1	Attitude Data Point Quality: att_data_ quality = "g" for a good data "r" for rejected data "m" for missing data	Determined and produced by LPS for each PCD major frame. "r" indicates that the attitude data is rejected due to failed range check. "m" indicates attitude data was found missing and is replaced with fill data.
ephem_data_quality	char8	1	Ephemeris Data Point Quality: ephem_data_quality = "g" for a good data "r" for rejected data "m" for missing data	Determined and produced by LPS for each PCD major frame. "r" indicates that the ephemeris data is rejected due to failed range check. "m" indicates ephemeris data was found missing and is replaced with fill data. .

4.1.3.3 PCD Conversion to Engineering Units (EUs)

This section contains notes and information for converting the Landsat 7 raw PCD, as necessary, to the Landsat 7 PCD engineering units (EUs). The Landsat 7 raw PCD format is specified in the Landsat 7 DFCB (Applicable Document 2.1.4). The PCD engineering unit notes are provided as a reference and to assist the developers in generating the LPS output PCD file specified in Section Table 4-17. These notes and/or information do not constitute a part of the LPS output PCD file format (Table 4-17).

4.1.3.3.1 ADS Data EUs

4.1.3.3.1.1 Data Extraction (Ref. L7 DFCB, Section 3.2.7.4.1)

ADS Sample size: 12 bits
ADS Sample Source: 2 PCD minor frames (16 bits)

msb lsb
0000 XXXX XXXX XXXX

where Xs indicate the 12 bits of an ADS sample.
The least significant bit value = $250/2^{11}$ or = 250/2048

ADS Sample Value: 0 - 2^{12} or 0 - 4095, where:

0 is the maximum positive angular displacement value,
2048 is the nominal zero angular displacement value, and
4095 is the maximum negative angular displacement value

4.1.3.3.1.2 Conversion to Engineering Units (EUs)

EU = (ADS Sample Value for the Nominal Zero angular Displacement - ADS Value) * $250/2^{11}$ microradians, OR
= (2048 -ADS sample Value) * 250/2048, OR
= (2048 -ADS Value) * 0.1220703125

4.1.3.3.1.1 Examples

a. For an ADS Sample Value = 0

The ADS EU Value = (2048 - 0) * 250/2048 = 250.1220703125 microradians

b. For an ADS Sample Value = 1024

The ADS EU Value = (2048 - 1024) * 250/2048 = 125 microradians

c. For an ADS Sample Value = 2048

The ADS EU Value = (2048 - 2048) * 250/2048 = 0 microradians

d. For an ADS Sample Value = 4095

The ADS EU Value = (2048 - 4095) * 250/2048 = -249.8779297 microradians

4.1.3.3.2 ADS Temperature EUs

4.1.3.3.2.1 Data Extraction (Ref. L7 DFCB, Section 3.2.7.4.2)

ADS Temperature Sample size: 12 bits
ADS Temperature Sample Source: 2 PCD minor frames (16 bits)

msb lsb
0000 XXXX XXXX XXXX

where Xs indicate the 12 bits of an ADS Temperature sample.
The least significant bit value = 0.0122 degrees Centigrade (L7 DFCB Table 11).

ADS Temperature Sample Value: 0000_{16} - $0FFF_{16}$ OR 0 - 4095, where:

0 = +50 degrees Centigrade, and
4095 = 0 degrees Centigrade

4.1.3.3.2.2 Conversion to Engineering Units (EU)

= (Max. ADS Temperature Sample Value - ADS Temperature Value) * 50/4096 degrees Centigrade, OR
= (4095 - ADS Temperature Value) * 0.01220703125 degrees Centigrade

4.1.3.3.2.3. Examples

a. For an ADS Temperature Sample Value = 0

The ADS Temperature EU Value = (4095 - 0) * 0.01220703125 = 49.987792969 degrees Centigrade

b. For an ADS Temperature Sample Value = 2047

The ADS Temperature EU Value = (4095 - 2047) * 0.01220703125 = 25.0 degrees Centigrade

c. For an ADS Temperature Sample Value = 4095

The ADS Temperature EU Value = (4095 - 4095) * 0.01220703125 = 0 degrees Centigrade

4.1.3.3.3 Gyro Data EUs

4.1.3.3.3.1 Data Extraction (Ref. L7 DFCB, Section 3.2.7.4.3)

There are three gyros with two output channels, A and B, each corresponding to the rates for two of three axes (X, Y, and Z). Therefore two measurements, A and B, are available for each axis. The Gyro outputs are configured as follows:

Gyro 1: output channels YA and ZA
Gyro 2: output channels XA and ZB
Gyro 3: output channels XB and YB

There is telemetry in the PCD to indicate which channel for each axis is sent down in the PCD, A or B. A change in the channels being sent down in the PCD should not affect the LPS processing.

Gyro Data Sample Readings: 3 (X, Y and Z)
Gyro Data Sample Reading Size: 24 bits
Gyro Data Sample Reading Source: 3 PCD minor frames (24 bits)

msb lsb
SXXX XXXX XXXX XXXX XXXX XXXX

where Xs indicate the 23 bits of a gyro data sample reading with S as the sign bit. The least significant bit value = 0.061 arc-seconds of angular motion

Gyro Data Sample Reading Values: -2^{23} to $+2^{23}-1$ OR
-8,388,607 to +8,388,606
where the engineering unit equivalents are:

-8,388,607 = -511,705.027 arc-seconds
0 = 0 arc-seconds
+8,388,606 = +511,704.966 arc-seconds

4.1.3.3.3.2 Conversion to Engineering Units

= Gyro Data Sample Reading * 0.061 arc-seconds

4.1.3.3.3.3 Examples

For Gyro Sample Readings:
IMU-X (Roll) = -1023
IMU-Y (Pitch) = 0
IMU-Z (Yaw) = +2047

The Gyro engineering unit values are:
IMU-X (Roll) = -1023*0.061 = -62.403 arc-seconds
IMU-Y (Pitch) = 0*0.061 = 0 arc-seconds
IMU-Z (Yaw) = +2047*0.061 = +124.867 arc-seconds

4.1.3.3.4 Gyro Drift Data EUs

4.1.3.3.4.1 Data Extraction (Ref. L7 DFCB, Section 3.2.7.4.4)

A gyro drift sample consists of three readings, one each for axis, X, Y, and Z. Each reading consists of 32 bits. The least significant bit of the extracted value is weighted at 2^{-47} (The 32-bit extracted word is calibrated at the least significant bit weight of 2^{-47} for computing the sample value.).

Gyro Drift Data Sample Readings: 3 (X, Y and Z)
Gyro Data Sample Reading Size: 32 bits (bit positions 2^{-17} thru 2^{-47} plus a sign bit)
Gyro Data Sample Reading Source: 4 PCD minor frames (32 bits)

a. Gyro Drift Data Sample Reading - Extracted

(2^{-17}) msb lsb (2^{-47})
SXXXXXXX XXXX XXXX XXXX XXXX XXXX XXXX

where Xs indicate the 31 bits of an extracted gyro drift data sample reading with S as the sign bit.

NOTE: The "msb" and "lsb" positions show data sample calibration points. They do not imply the use of any specific word size (input or output) for the gyro drift data.

b. Gyro Drift Data Sample Reading - Weighted

- For a positive (S = 0) Reading:

(2^{-17}) msb lsb (2^{-47})
0XXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

- For a negative (S = 1) Reading:

(2^{-17}) msb lsb (2^{-47})
1XXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

Gyro Drift Sample Reading Values: -2^{-16} to $+2^{-16} - 2^{-47}$ OR
-1.5259E-05 to +1.5259E-05

where the engineering unit equivalents are:

-1.5259E-05 = -2.9802E-08 radians/milliseconds
7.1054E-15 = 1.3878E-17 radians/milliseconds (Bit 2^{-47} (lsb) EU value)
+1.5259E-05 = +2.9802E-08 radians/milliseconds

4.1.3.3.4.2 Conversion to Engineering Units

= Gyro Drift Data Sample Reading (radians) / 512 (milliseconds)

4.1.3.3.4.3 Examples

For gyro drift sample readings:
Theta X = -1.5259E-05
Theta Y = 7.1054E-15
Theta Z = +1.5259E-05

The gyro drift engineering unit values are:

Theta X = -1.5259E-05 / 512 = -2.9802E-08 radians/milliseconds
Theta Y = 7.1054E-15 / 512 = 1.3878E-17 radians/milliseconds
Theta Z = +1.5259E-05 / 512 = +2.9802E-08 radians/milliseconds

4.1.4 Calibration Data File Format (HDF-EOS Swath)

4.1.4.1 Calibration Data File - Swath Format Overview

The LPS uses the HDF-EOS Swath object structure for generating LPS calibration data files. An LPS calibration data file contains all HDF-EOS Swath objects required for all bands of the calibration data in an ETM+ Format 1 or Format 2 subinterval. A swath object for each band of the calibration data, present in an ETM+ format, is provided by LPS. The calibration data swath file for an ETM+ Format 1 subinterval consists of six swath objects, arranged in band sequential order, one each for Bands 1–6. The calibration data swath file for an ETM+ Format 2 subinterval consists of three swath objects, one each for Bands 6–8. Figures 4-3 and 4-5 provide an overview of the HDF-EOS swath structure for the LPS output calibration file.

Each calibration swath object consists of cal. data fields and cal. geolocation fields. Cal. data fields in a swath contain cal. data lines from one band. The geolocation fields provide identification and construction information for each cal. line in a swath. A dimension map provides the linkage between geolocation fields to its associated cal. data line. Tables 11 through 16 define the calibration swath.

4.1.4.2 Calibration Data File Volume(s)

The following sizing assumptions are used to define the range of values included in the calibration file:

1. ETM+ Scans per Scene:
   - Nominal: 335 (Received WRS scene without scans overlap)
   - Maximum: 375 (Distribution WRS scene with scans overlap)

2. Scan Data Lines (Nominal, without scans overlap) per Scene:
   - Bands 1–5 and 7: 335 x 16 = 5,360
   - Band 6: 335 x 8 = 2,680
   - Band 8: 335 x 32 = 10,720

3. Scan/Cal Data Lines (Maximum with scans overlap) per Scene:
   - Bands 1–5 and 7: 375 x 16 = 6,000
   - Band 6: 375 x 8 = 3,000
   - Band 8: 375 x 32 = 12,000

4. Subinterval Duration: ~14 minutes (Maximum)
   (Longest possible contact period duration - worst case)

5. Scene Duration: ~ 24 seconds

6. Number of Scenes (Maximum) per Subinterval: ~ 35

(For the longest possible contact period with a single subinterval)

7. ETM+ Scans per Subinterval (scans do not overlap):
   Maximum: 335 x 35 = 11,725

8. Scan/Calibration Data Lines (Maximum) per Subinterval (scans do not overlap):
   - Bands 1–5 and 7: 5,360 x 35 = 187,600
   - Band 6: 2,680 x 35 = 93,800
   - Band 8: 10,720 x 35 = 375,200

9. Calibration Data Line Lengths (Received, Nominal):
   (Calibration Data + Garbage Data + Fill Data + Error)
   - Bands 1–5 and 7: 960 +16 + 112 + 12 = 1,100 Bytes
   (Check: Total Line Length - Active Scan Length = 7,423 - 6,323 = 1,100)
   - Band 6: 1,100 / 2 = 550 Bytes
   - Band 8: 1,100 x 2 = 2,200 Bytes

10. LHS Margins: Bumper Wear + Extra
    - Bands 1–5 and 7: 17 + 23 = 40 Bytes.
    - Band 6: 40/2 = 20 Bytes (Margin is halved)
    - Band 8: 40 x 2 = 80 Bytes (Margin is doubled)

11. RHS Margins: Alignment Space + Bumper Wear + Extra
    - Bands 1–5 and 7: 206 + 17 +17 = 240 Bytes
    - Band 6: 240/2 = 120 Bytes (Margin is halved)
    - Band 8: 240 x 2 = 480 Bytes (Margin is doubled)

12. Calibration Data Output Line Lengths (Maximum):
    (Nominal + LHS side Margin + RHS Margin)
    - Band 1–5 and 7: 1,100 + 40 + 240 = 1,380 Bytes
    - Band 6: 550 + 20 + 120 = 690 Bytes (or 1,380/2)
    - Band 8: 2,200 + 80 + 480 = 2,760 Bytes (or 1,380 x 2)

13. Subinterval Calibration Data File Volumes (Maximum):
    - Band 1–5 and 7: 187,600 x 1,380 = ~ 0.259 GB
    - Band 6: 93,800 x 690 = 0.065 GB
    - Band 8: 375,200 x 2,760 = ~ 1.036 GB

14. Calibration Data File Volume (All Subinterval Bands, Maximum):
    Format 1: (Bands 1–6): 0.259 x 5 + 0.065 = 1.36 GB
    Format 2: (Bands 6–8): 0.065 + 0.259 + 1.036 = 1.36 GB

4.1.4.3 Calibration Fill Data

Calibration data will be filled similarly to Band data. See section 4.1.1.3.

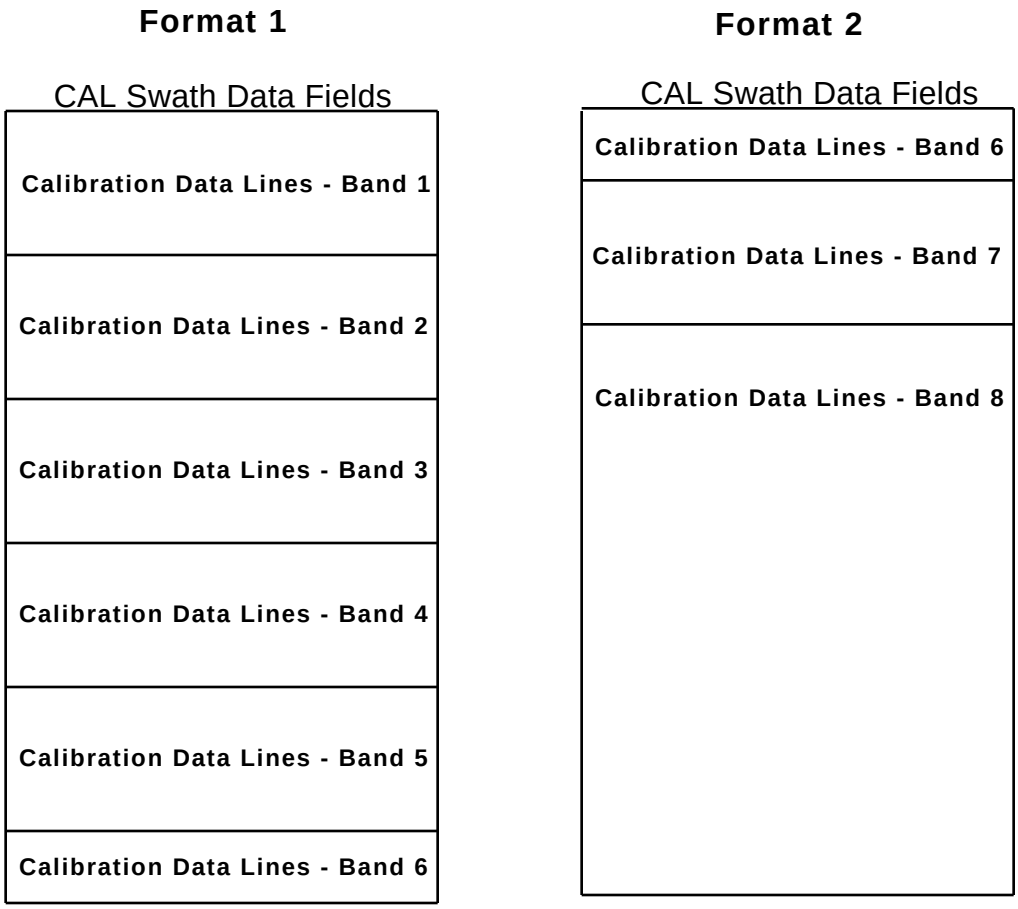
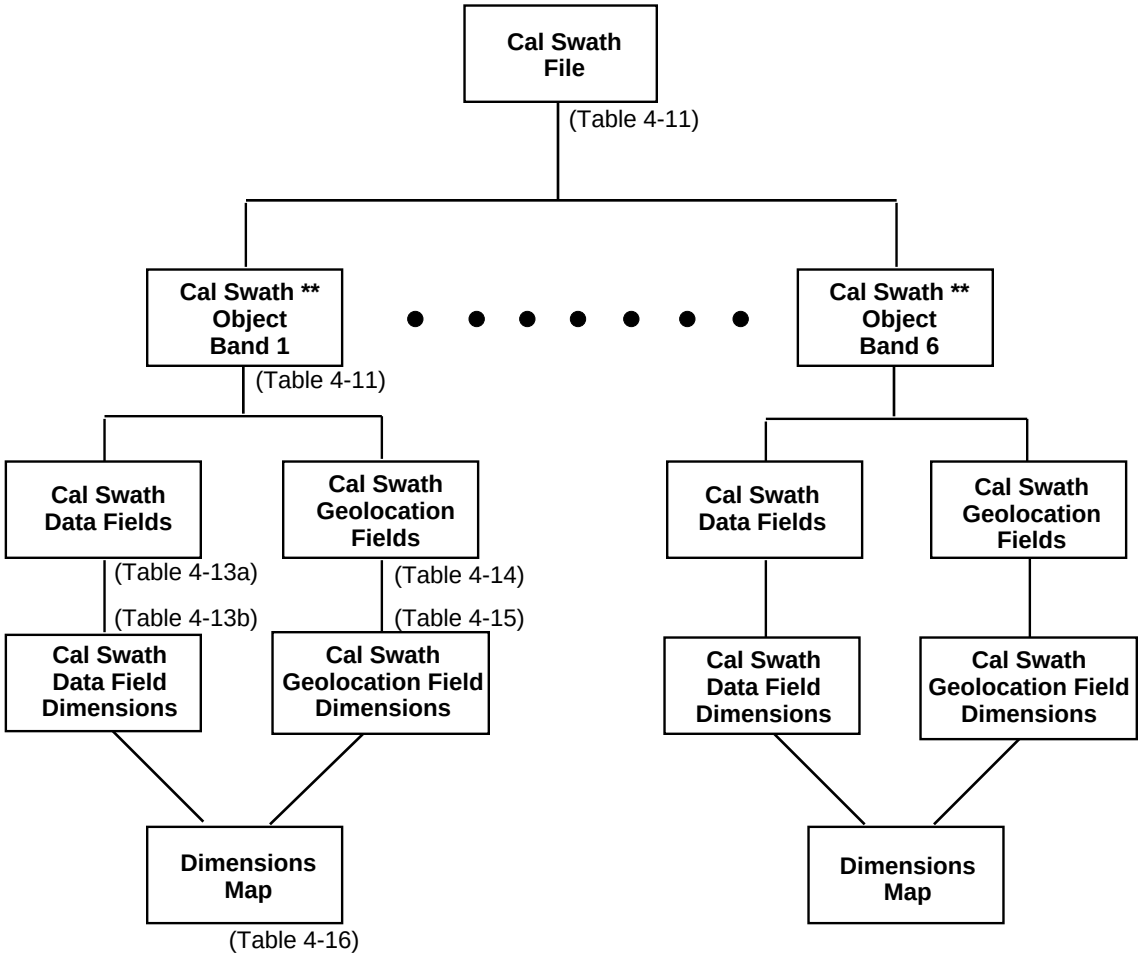


Figure 4-3: Format 1 and 2 Calibration Data Files - Band Sequential Organization



**** Cal. data from each band is included in a separate swath object. The Format 1 file consists of swath objects for Bands 1-6. The Format 2 Cal. file consists of swath objects for bands 6-8.**

Figure 4-4: Calibration Data File (Format 1 Example) HDF-EOS Swath Structure

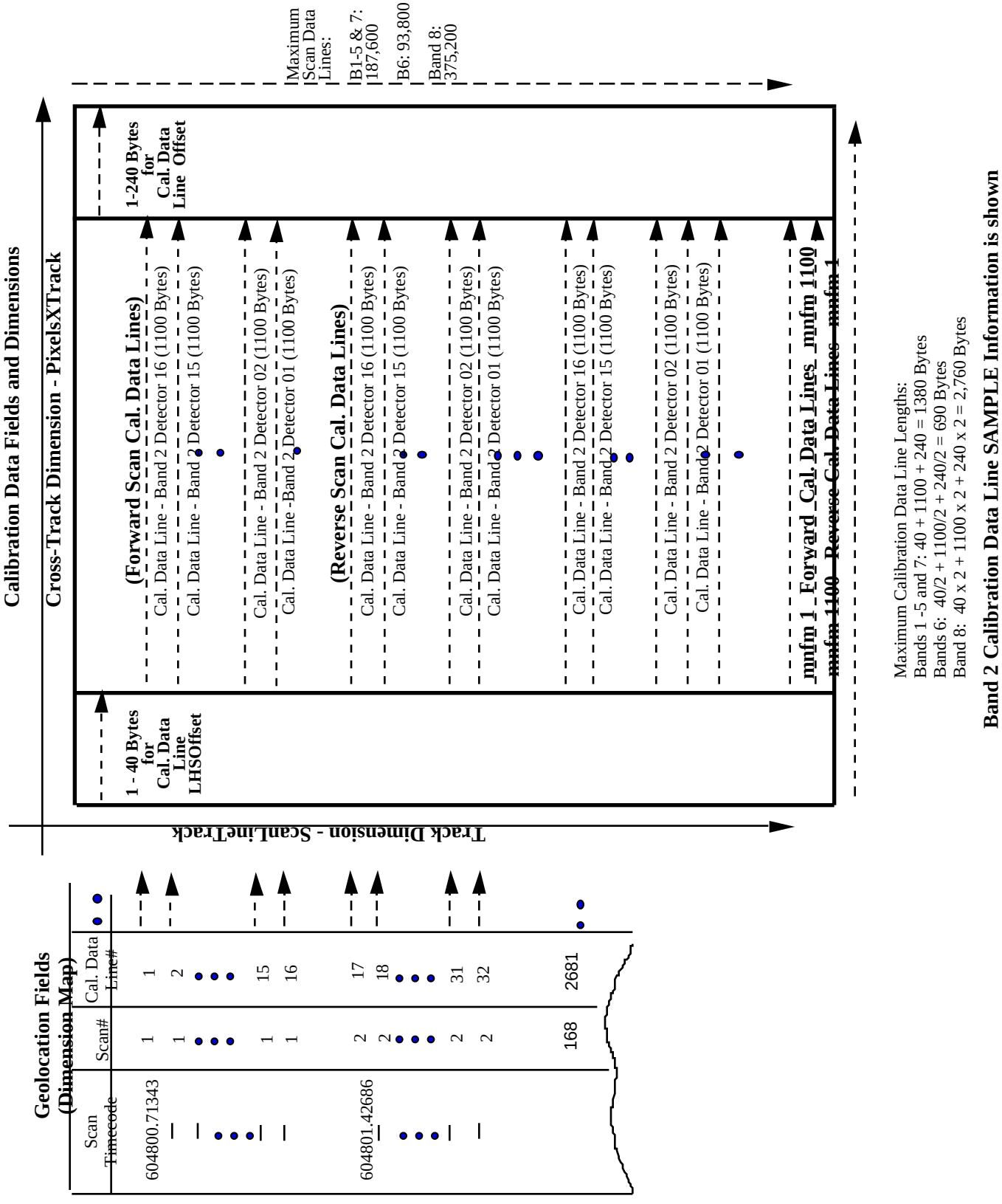


Figure 4-5: Calibration Data File - ECS-HDF Swath Overview

Table 4-11: Calibration Data File and Swath Definition Parameters

Swath Definition Parameter	Number Type and (Size)	Value, Format, Range and Unit	Parameter Description / Remarks
file_name	char8 (22)	= L7XsssfnYYDOYHHuuv.xxx where xxx = CAL for a calibration data file.	See Section 3.4 for complete details on the LPS file naming convention. The LPS generates a calibration data file each for the ETM+ Format 1 and Format 2 data subintervals.
swath_name	char8 (13)	= Cal_Swath_Cis where "Cal_Swath_" identifies a Landsat 7 calibration data HDF-EOS swath object. One calibration data swath object is produced for each band in an ETM+ format, Format 1 or Format 2. All calibration data swath objects for an ETM+ format are included (grouped) in a single calibration data file (file name shown above). Cis identifies ETM+ Format 1 and Format 2 calibration data source bands as follows: Ci = C1–C8 for Calibration data source Bands 1–8 s = 0 for single segment swaths for Bands 1–6 in an ETM+ Format 1 calibration data file s = 0 for single segment swaths for Bands 6–8 in an ETM+ Format 2 calibration data file.	Defined in accordance the xxx = "Bis" extension used in the LPS file naming convention. The Format 1 calibration data file contains the following calibration data swaths (names): = Cal_Swath_C10 = Cal_Swath_C20 = Cal_Swath_C30 = Cal_Swath_C40 = Cal_Swath_C50 = Cal_Swath_C60 The Format 2 calibration data file contains the following calibration data swaths (names): = Cal_Swath_C60 = Cal_Swath_C70 = Cal_Swath_C80 Note: Calibration data for Band 8 is not segmented into multiple swaths or Calibration Files.

Table 4-12: Calibration Data File - CAL Swath Attributes

Attribute Name	Number Type (ntype)	Count	Attribute Values	Remarks
detector_count	int8	1	= 16 for Bands 1–5 and 7, = 8 for Band 6, and = 32 for Band 8	

Table 4-13a: Calibration Data File_CAL Swath Data

Data Field Name	Number Type	Count	Value	Remarks
cal_band_detector_ data	uint8	1380	= 20-255 (grays cal pixel data)	Cal. data (bytes) is extracted from a single detector of a band to form a cal. data line. The number of cal. data lines formed for each band depends on detector_count (Table 4-12). A cal. data line consists of band_detector data from each minor frame starting with the End-of-Line (EOL) minor frame until the start of a new scan. See Section 4.1.4.2 for detail on cal. data line components and maximum number of lines for a band.

Table 4-13b: Calibration Data File - CAL Swath Data Field Dimensions

Data Field Name	Number Type	Cross-Track Dimension Name and Size	Track Dimension Name and Size	Merge Code
cal_band_detector_data	uint8	Name: PixelsXTrack Size: = 1,380 for Bands 1–5 and 7 = 690 for Band 6 = 2,760 for Band 8 Notes: This dimension includes the End-of-Line (EOL) and Scan Line Direction (SLD) minor frame data as follows: = 2 for Bands 1–5 and 7 = 1 for Band 6 = 4 for Band 8	Name: ScanLineTrack Size: scan_no x detector_count where scan_no = 1–11,725 and detector_count is as defined in Table 4-12. The possible range for ScanLineTrack Size = 1–187,600 for Bands 1–5 and 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8	= HDFE_ NOMERGE (0) (no merge) Keep calibration data swaths separate for each band.

Table 4-14: Calibration Data File - CAL Swath Geolocation Fields

Geolocation Field Name	Number Type	Count	Value	Remarks
scan_timecode	char8	25	Scan line time of the form 'YYYY:ddd:hh:mm:ss.tttttt' where YYYY: four-digit Julian year ddd: day (01 through 366**) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) tttttt: fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) ** For cases when active imaging occurs at the end of a leap year.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame data reported in this record. A computed scan start time is provided if a valid time is not available from the ETM+ time code minor frames.
Time	float64	1	The ETM+ scan time in seconds since midnight on January 1, 1993, rounded to 7 decimal places.	The scan time is obtained by converting the scan_timecode (see below) to seconds. The ECS Project/HDF requires scan times in the seconds format and with the field name 'Time' to search data archives.
scan_no	uint16	1	scan_no = 1–11,725 The maximum scan count is based on a subinterval duration of 14 minutes for 35 scenes, each consisting of 375 (355+20) scans.	Provides a sequence counter for ETM+ scans (major frames) contained in a subinterval. The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the subinterval file.
cal_data_line_no	uint32	1	cal_data_line_no = SSSSSS where SSSSSS = 1–187,600 for Bands 1–5 and 7 = 1–93,800 for Band 6 = 1–375,200 for Band 8 Note: All Band 8 calibration data lines are included in a single swath (not segmented like the band swath). See Section 4.1.4.2 for details.	The cal. data line counter is incremented for each calibration data line added to the calibration data swath.

Geolocation Field Name	Number Type	Count	Value	Remarks
scan_dir	char8	1	Scan direction character 'F' = Forward scan 'R' = Reverse scan 'U' = Unknown scan direction	The current ETM+ scan direction information obtained directly from the word 5, bit 1 of the PCD/Status data for the current scan. A valid ETM+ major frame has no errors. The default Forward direction will be used as the scan direction for the scan for the purpose of placing the data if the direction is unknown.
detector_id	uint8	1	where detector_id is in the range: = 1–16 for Bands 1–5 and 7 = 1–8 detectors for Band 6 = 1–32 for Band 8	Each data line in a calibration data swath consists of pixel data (bytes) from a single detector of a single band (see Figure 4-5). Each detector, chosen in a descending ID order, is used once during each scan for generating a scan line.
cal_data_line_ offset_rhs	int8	1	= 0–280 bytes for Bands 1–5 and 7 = 0–140 bytes for Bands 6 (Format 1 and Format 2) = 0–560 bytes for Band 8 The cal. line data may be shifted to right in the band data buffer after an integer-pixel alignment. The maximum value in the above ranges represents the sum of the rhs plus lhs offsets before bumper wear.	The calibration line data in each record of the calibration data swath is initially written with a predetermined size of byte offset on the left and right of the designated scan line data area with a pattern of zeros. During integer-pixel alignment, these offsets provide moving in space (to avoid data loss) for the right-shifted band-detector data. After an integer-pixel alignment, this field indicates the resulting start and stop bytes/pixel positions for scan lines. This offset also accommodates scan line length growths due to ETM+ scanner bumper wear. (See Figure 4-5)
cal_data_line_ offset_lhs	int8	1	= 0–280 bytes for Bands 1–5 and 7 = 0–140 bytes for Band 6 = 0–560 bytes for Band 8 The cal. line data may be shifted to left in the band data buffer after an integer-pixel alignment.	Note: The left-hand-side offset is not as significant as the right-hand-side margin. It can accommodate scan/cal. line length growths due to ETM+ scanner bumper wear. (See Figure 4-5) This value is dependent on values in the calibration parameter file.

Table 4-15: Calibration Data File - Cal Swath Geolocation Field Dimensions

Geolocation Field Name	Number Type	Track Dimension Name and Size	Merge Code
scan_timecode	char8	Name: ScanLineTrack Size: 1–11,725	= HDFE_ AUTOMERGE (1) (OK to merge fields with shared dimensions and/or data type)
Time	float64	Name: ScanLineTrack Size: 1–11,725	= HDFE_ AUTOMERGE (1)
scan_no	uint16	Name: ScanLineTrack Size: 1–11,725	= HDFE_ AUTOMERGE (1)
cal_data_line_no	uint32	Name: ScanLineTrack Size: 1–11,725 x detector_count (See Table 4-12)	= HDFE_ AUTOMERGE (1)
scan_dir	char8	Name: ScanLineTrack Size: 1–11,725	= HDFE_ AUTOMERGE (1)
detector_id	uint8	Name: ScanLineTrack Size: 1–11,725x detector_count (See Table 4-12)	= HDFE_ AUTOMERGE (1)
cal_data_line_offset_ rhs	int8	Name: ScanLineTrack Size: 1–11,725 x detector_count (See Table 4-12)	= HDFE_ AUTOMERGE (1) (merge)
cal_data_line_offset_ lhs	int8	Name: ScanLineTrack Size: 1–11,725 x detector_count (See Table 4-12)	= HDFE_ AUTOMERGE (1) (merge)

Table 4-16: Calibration Data File - HDF Swath Dimension Map

Geolocation Dimension Name	Data Dimension Name	Offset	Increment
TimecodeTrack	ScanLineTrack	= 0 The timecode starts with the first scan line.	= detector_count The timecode repeats at detector count intervals.
TimeTrack	ScanLineTrack	= 0	= detector_count
ScanTrack	ScanLineTrack	= 0	= detector_count
ScanLineNoTrack	ScanLineTrack	= 0	= 1
ScanDirTrack	ScanLineTrack	= 0	= detector_count
DetectorIDTrack	ScanLineTrack	= 0 The detector ID starts with the first scan line.	= 1 The detector ID repeats on a scan line basis.
LhsOffsetTrack	ScanLineTrack	= 0 The left-hand side offset starts with the first scan line.	= 1 A left-hand side offset is present for each scan line.
RhsOffsetTrack	ScanLineTrack	= 0	= 1

4.2 Metadata File Format (ODL)

4.2.1 Metadata File Description

The LPS generates individual metadata files for the ETM+ Format 1 and Format 2 subintervals. These files consist of two levels of metadata: the subinterval and the WRS scene level. The subinterval level metadata contains reference information on the subinterval raw wideband data source (e.g., an LGS X-band channel), the LPS resources (equipment strings) used in Level 0R processing, and identification information on the Level 0R data files produced for a Format 1 or a Format 2 subinterval. The WRS scene level metadata contains information on each WRS scene identified for a subinterval during Level 0R processing. The WRS scene level metadata is further divided into scene metadata groups. Each scene metadata group contains identification information on a WRS scene, its geolocation references (e.g., scene center and corner information), its cloud cover assessment scores, and quality and accounting information on the band (image) and payload correction data associated with the WRS scene. The WRS scene level metadata may contain information on up to 35 full WRS scenes for a 14-minute Landsat 7 contact period.

The LPS metadata file for a Format 1 subinterval contains subinterval level and WRS scene level metadata for Bands 1–6. The LPS metadata file for a Format 2 subinterval contains subinterval level and WRS scene level metadata for Bands 6–8. The multiband-scene browse file names and the automated cloud cover assessment (ACCA) results are provided in the ETM+ Format 1 (Bands 1–6) subinterval metadata only. Section 4.2.3 contains examples of the LPS Format 1 and Format 2 subinterval metadata files.

The LPS metadata file format conforms to the Object Description Language (ODL) standard. Details on the ODL standard are provided in Applicable Document 2.1.7. Table 4-17 provides details on LPS parameter values and their formats for constructing the ETM+ Format 1 and Format 2 metadata files. In accordance with the ODL standard, all parameters and values are presented using ASCII standard characters.

The following notes apply to the construction of LPS metadata statements:

1. Leading zeros are omitted from all values except for parameters associated with WRS path and row (e.g., WRS_PATH and WRS_ROW) and in the metadata GROUP and END_GROUP statements (including a multiple digit field).

2. All fixed length character strings, including single character strings such as "+", "-", "Y", and "N" characters, are enclosed with quotes (" "). This includes file names.

3. All values equal to or greater than zero (0) are considered positive. All values less than zero (0) are considered negative. Plus signs "+" are not explicitly needed in front of positive values.

Table 4-17: Metadata File Format - ODL Parameter Values

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
GROUP	13	= METADATA_FILE	Beginning of the first level ODL group. It indicates the start of the LPS Metadata File Level Group records for an ETM+ Format 1 or Format 2 subinterval.
GROUP	18	= METADATA_FILE_INFO	Beginning of the second level ODL group. It indicates the start of the LPS Metadata File information Group records.
FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" where xxx = "MTA" for the metadata file.	Complete details on the LPS file naming convention are specified in Section 3.4.
FILE_CREATION_DATE_ TIME	20	= YYYY-MM-DDThh:mm:ssZ where YYYY = four-digit Julian year (e.g., 1998 and 2001) MM = month number of a Julian year (01–12 for January to December) DD = day of a Julian month (01–31) T indicates the start of time information in the ODL ASCII time code format hh = hours (00–23) mm = minutes (00–59) ss = seconds (00–59) Z indicates "Zulu" time (same as GMT)	The LPS system date and time when the metadata file for a Level 0R file set was created. For ease of human readability, this date and time information is presented in the ODL ASCII format. The time is expressed as Universal Coordinated Time (also known as Greenwich Mean Time (GMT)). Insertion of additional characters "T" and "Z" is required to meet the ODL ASCII time format.
FILE_VERSION_NO	1	= 0–9 where FILE_VERSION_NO = 0 indicates "not a reprocessed file" FILE_VERSION_NO = 1–9 indicates the file reprocess count. The one_digit LPS File Version number is also used in the FILE_NAME.	Reprocessing indicator to distinguish this file from the metadata file generated earlier for the same subinterval and provided to the EDC DAAC. The reprocessing information is entered/supplied by an operator during setup of the Level 0R processing operations.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
STATION_ID	3	= SSS where SSS indicates a three character ground station code. For LPS, SSS = "EDC" for station contacts received directly at EDC. For data received from other stations, SSS = “AGS” for Fairbanks, Alaska and “SGS” for Svalbard, Norway. If data is received on tape from an IGS station then the IGS station ID is used. See the *L7 to IGS ICD* (Applicable Document 2.1.13) for the full set of IGS stations.	This parameter identifies the Landsat 7 ground station that received the raw data from L7. This parameter is to distinguish the metadata and its associated Level 0R files processed from data received directly at EDC and data coming from other ground stations.
SOFTWARE_VERSION_NO	5	= "X.Y.Z" where X is the major release number Y is the minor release number Z is the patch (or engineering) release number X, Y, Z are all numeric values	Version number of the software installed on the LPS string when a metadata and its associated Level 0R files were generated.
L7_CPF_NAME	25	="L7CPFyyyymmdd_yyyymmdd.nn" where yyyymmdd = effective_date_begin and effective_date_end respectively nn = incrementing number for within a quarter (00-99)	The name of the Landsat 7 Calibration Parameter file (CPF) received from IAS and used in generating the Level 0R files identified in this metadata file. 00 is only valid for the pre-launch CPF.
END_GROUP	18	= METADATA_FILE_INFO	End of the second level ODL group. It indicates the end of the LPS Metadata File information Group records.
GROUP	26	= SUBINTERVAL_METADATA_FMT_m where m = 1 for Format 1 OR m = 2 for Format 2	Beginning of the second level ODL group. It indicates the start of the ETM+ Format 1 or Format 2 subinterval level Metadata group records.
SPACECRAFT_ID	8	= "Landsat7"	
SENSOR_ID	4	= "ETM+"	

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
CONTACT_PERIOD_START_TIME	18	YYYY-DOYTHH:MM:SSZ where YYYY = four-digit Julian year DOY = Julian day of year (001–366) T indicates the start of time information in the ODL ASCII time code format HH = hour of day (00–23) MM = minutes (00–59) SS = seconds (00–59) Z indicates "Zulu" time (same as GMT)	The Julian date and GMT when the capture of a Landsat 7 contact period, associated with this subinterval, was started by the LPS. Insertion of additional characters "T" and "Z" is required to meet the ODL ASCII time format.
CONTACT_PERIOD_STOP_TIME	18	YYYY-DOYTHH:MM:SSZ (See above: CONTACT_PERIOD_START_TIME)	The Julian date and GMT when the capture of a Landsat 7 contact period, associated with this subinterval, was completed by the LPS.
STARTING_PATH	3	= 001–233 (leading 0s are required)	The starting WRS path number for the scenes included in this subinterval.
STARTING_ROW	3	= 001–248 (leading 0s are required)	The starting WRS row number for the scene data included in this subinterval.
ENDING_ROW	3	= 001–248 (leading 0s are required)	The ending WRS row number for the scene data included in this subinterval.
SUBINTERVAL_START_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where YYYY = four-digit Julian year ddd = day (001–366*) T indicates the start of time information in the ODL ASCII time code format hh = hours (00–23) mm = minutes (00–59) ss = seconds (00–59) ttttttt = fractional seconds (0–9999375, where the clock cycle is 1/16 millisecond) Z indicates "Zulu" time (same as GMT) * For cases when active imaging occurs at the end of a leap year.	The spacecraft time extracted from the timecode minor frames of the first ETM+ major frame of the subinterval reported in this file. A computed start time is provided if the timecode in the first ETM+ major frame is in error. Note: The year information (Capitalized) is appended by LPS to the spacecraft timecode. Insertion of additional characters "T" and "Z" is required to meet the ODL ASCII time format.
SUBINTERVAL_STOP_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_TIME, above.	The spacecraft time extracted from the timecode minor frames of the last ETM+ major frame of the subinterval reported in this file. Note: The year information (Capitalized) is appended by LPS to the spacecraft timecode.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
TOTAL_ETM_SCANS	1–5	= N–11725 where N is an LPS operator selectable parameter value for the smallest scene size to be included in a subinterval. The default value of N is 335.	The total number of ETM+ scans reported in this subinterval file. A maximum of 11,725 scans can be received in a 14-minute subinterval (based on a maximum of 35 full scenes, each consisting of at most 335 scans)
PCD_START_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_TIME, above.	Spacecraft time of the first PCD major frame in the PCD file associated with this subinterval.
PCD_STOP_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_TIME, above.	Spacecraft time of the last PCD major frame in the PCD file associated with this subinterval.
TOTAL_PCD_MAJOR_ FRAMES	1–3	= 0–255	The total number of PCD major frames received in the PCD file associated with this subinterval. Approximately 212 major frames can be received by the LPS during a 14-minute subinterval.
SUBINTERVAL_UL_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	LPS calculated "actual" latitude value for the upper left corner of the subinterval. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UL_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	LPS calculated "actual" longitude value for the upper left corner of the subinterval. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UR_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	LPS calculated "actual" latitude value for the upper right corner of the subinterval. A subinterval may start at the first actual scan (not filled) in a partial scene.
SUBINTERVAL_UR_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	LPS calculated "actual" longitude value for the upper right corner of the subinterval. A subinterval may start at the first actual scan (not filled) in a partial scene.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SUBINTERVAL_LL_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	LPS calculated "actual" latitude value for the lower left corner of the subinterval. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_LL_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	LPS calculated "actual" longitude value for the lower left corner of the subinterval. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_LR_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	LPS calculated "actual" latitude value for the lower right corner of the subinterval. A subinterval may end at the last actual scan (not filled) in a partial scene.
SUBINTERVAL_LR_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	LPS calculated "actual" longitude value for the lower right corner of the subinterval. A subinterval may end at the last actual scan (not filled) in a partial scene.
ETM_LAST_ON_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_TIME, above.	See the Landsat 7 DFCB for details on this time.
ETM_LAST_OFF_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_TIME, above.	See description, above, for ETM+_LAST_ON_TIME.
UT1_CORRECTION	8	= -0.90000–+0.90000 seconds This time could be as large as 0.9 seconds in increments of fractions of seconds.	The UTC-UT1 time difference in seconds obtained from the Landsat 7 Calibration Parameter file received from IAS.
BAND1_PRESENT	1	= "Y" indicates that Band 1 is present in this subinterval OR = "N" indicates that Band 1 is not present in this subinterval This field is included in the ETM+ Format 1 metadata only.	This is the "Band 1 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 0, where a bit set condition. (=1) indicates "Band 1 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND2_PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	This is the "Band 2 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 1, where a bit set condition (=1) indicates "Band 2 ON state." The first error-free PCD major frame (2) is used to derive this value.
BAND3_PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	This is the "Band 3 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 2, where a bit set condition (=1) indicates "Band 3 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND4_PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	This is the "Band 4 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 3, where a bit set condition (=1) indicates "Band 4 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND5_PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	This is the "Band 5 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 4, where a bit set condition (=1) indicates "Band 5 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND6_PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 or Format 2 metadata.	This is the "Band 6/MIR ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND7_PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 2 metadata only.	This is the "Band 7 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 6, where a bit set condition (=1) indicates "Band 7 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND8_PRESENT	1	(Same as BAND1_PRESENT values and format). This field is included in the ETM+ Format 2 metadata only.	This is the "Band 8 ON" status information obtained from PCD Serial Word "E" (major frame (2), minor frame 35, word 72), bit 0, where a bit set condition (=1) indicates "Band 8 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
TOTAL_WRS_SCENES	1–2	= 0–99 This field is included in both ETM+ Format 1 and 2 metadata. Note The LPS produces this count from the total number of WRS scenes identified in a subinterval. The LPS does not use the absolute difference between STARTING_ROW and ENDING_ROW to compute this +1 count.	This count indicates the total number of WRS scenes identified by LPS in a subinterval. A maximum of 35 full WRS scenes, plus partial scenes at the start and/or the end of a subinterval, may be received by LPS in a 14-minute subinterval. This count also indicates the total number of multiband-scene browse files, for full and partial scenes, that may be produced by LPS and reported in the scene metadata.
PARTIAL_WRS_SCENES	1	= 0–2 This field is included in both ETM+ Format 1 and 2 metadata.	Indicates the count of partial scenes, if any, at the start and/or at the end of a subinterval.
TOTAL_FILES	1–2	= 10–47 (Format 1 with up to 37 multiband browse scene files) OR = 6 - 9 (Format 2 with up to 3 Band 8 file segments)	The total number of LPS files included in this subinterval for ETM+ Format 1 or Format 2. Assuming that a subinterval contains at least one scene, the metadata file will contain the names of a minimum of 10 files (6 Band, 1 MSCD, 1 PCD, 1 Calibration and 1 Multiband-scene Browse Files) for Format 1, and 6 files (3 band, 1 MSCD, 1 PCD, and 1 Calibration files) for Format 2, respectively. A maximum of 35 full multiband scene browse files are provided for Format 1 subinterval only.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND1_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 1 file name: xxx = B10 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND2_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 2 file name: xxx = B20 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND3_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 3 file name: xxx = B30 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND4_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 4 file name: xxx = B40 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND5_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 5 file name: xxx = B50 (Format 1 only)	This file name is included in a Format 1 metadata file only.
BAND6_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 6 file name: xxx = B60 (Format 1 or Format 2)	This file name is included in a Format 1 or Format 2 metadata file.
BAND7_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 7 file name: xxx = B70 (Format 2 only)	This file name is included in a Format 2 metadata file only.
BAND8_FILE1_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 8, Segment 1 file name: xxx = B81 (Format 2 only)	This Band 8 file segment name is included in a Format 2 metadata file only. Up to three Band 8 file segments, each up to 2 GB long, are expected in a Format 2 subinterval.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND8_FILE2_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 8, Segment 2 file name: xxx = B82 (Format 2 only)	The name of this Band 8 file segment, if it exists in a subinterval, is included in a Format 2 metadata file only.
BAND8_FILE3_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details on the file naming convention.) For the Band 8, Segment 3 file name: xxx = B83 (Format 2 only)	The name of this Band 8 file segment, if it exists in a subinterval, is included in a Format 2 metadata file only.
MSCD_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4 for details) xxx = MSD for an MSCD file	Name of the Mirror Scan Correction Data (MSCD) file associated with this subinterval.
PCD_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4) xxx = PCD for a PCD file	Name of the Payload Correction Data (PCD) file associated with this subinterval.
CAL_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" (See Section 3.4) xxx = CAL for a Calibration file	Name of the Calibration file associated with this subinterval.
Scene Level Metadata **(not an LPS metadata parameter)**			**The following parameters values are repeated for each ETM+ Format 1 or Format 2 scenes included in a subinterval.**
GROUP	17	= METADATA _SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected in a 14-minute subinterval)	Beginning of the second level ODL group. It indicates the beginning of the ETM+ Format 1 or Format 2 Scene NN level Metadata group records.
GROUP	12	= WRS_SCENE_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the ETM+ Format 1 or Format 2 WRS Scene 1 Metadata group records.
Scene Level Metadata **(not an LPS metadata parameter)**			**The following parameters values are repeated for each WRS scene included in the subinterval.**
WRS_SCENE_NO	1–2	= 1–99	This is the LPS assigned WRS scene number within a subinterval.
FULL_OR_PARTIAL_ SCENE	1	= "F" or "P" where F indicates a full WRS scene OR P indicates a partial WRS scene at the start or end of a subinterval.	The LPS may receive partial WRS scenes at the start and/or the end of a subinterval.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BROWSE_FILE_NAME	22	= "L7XsssfnYYDOYHHuuv.xxx" for a Format 1 subinterval (See Section 3.4) OR No browse file names are provided if its a Format 2 subinterval. xxx = Rnn where R indicates a Multiband Scene Browse file, and nn = 00–99 indicates the Multiband Scene Browse file number within a subinterval.	The LPS generates Multiband Scene Browse files for ETM+ Format 1 (Bands 1–6) only. The names of all Multiband Scene Browse files, generated for a Format 1 subinterval, are provided with and reported in the Format 1 metadata. A maximum of 35 full WRS scenes are possible in a subinterval.
WRS_PATH	3	= 001–233 (leading zeros are required)	The WRS path number associated with the scene from PCD scene accounting.
WRS_ROW	3	= 001–248 (leading zeros are required)	The WRS row number associated with the scene
SCENE_CENTER_SCAN_NO	2–5	= 1–11725 (for "actual" scene centers in the subinterval.) For a partial scene with less than a half scene length data, the scene center scan number may be outside the actual subinterval band data range. It will be pointed to the non-existent scan 0 in the band file.	The ETM+ scan number nearest the calculated (actual) center of a WRS scene. A WRS scene scan number within a 14-minute subinterval can be as high as 11,725.
SCENE_CENTER_SCAN_TIME	26	= YYYY-dddThh:mm:ss.ttttttttZ where the time format is the same as for SUBINTERVAL_START_TIME, above.	The spacecraft time associated with a WRS scene center scan (number).
SCENE_CENTER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS Scene Center Latitude - LPS calculated coordinate value. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the band file. The computed "actual" scene centers for smaller than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the band file.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_CENTER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	WRS Scene Center Longitude - LPS calculated coordinate value. The computed "actual" scene centers for full and greater than half a scene length partial scenes are expected to be in the proximity of the nominal WRS scene centers. They are always indexed to actual data in the band file. The computed "actual" scene centers for less than half a scene length partial scenes are also expected to be in the proximity of the nominal WRS scene centers, but outside the actual subinterval band data range. They are indexed to a non-existent scan 0 in the band file.
HORIZONTAL_DISPLAY_ SHIFT	2–5	= - 9999 through + 9999 meters A negative (-) value defines a shift of the calculated "true" WRS scene center to the West of the nominal WRS scene center. A positive (+) value defines a shift of the calculated "true" WRS scene center to the EAST of the nominal WRS scene center.	The horizontal distance between the perpendiculars through the LPS calculated "true" WRS Scene Center and the nominal (known) WRS scene center on ground. The LPS will maintain a lookup table of nominal WRS scene centers for computing the HORIZONTAL_DISPLAY_ SHIFT (HDS) values for WRS scenes.
SCENE_UL_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene upper left corner "actual" latitude for a full or a partial scene.
SCENE_UL_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	WRS scene upper left corner "actual" longitude for a full or a partial scene.
SCENE_UR_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene upper right corner "actual" latitude for a full or a partial scene.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_UR_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	WRS scene upper right corner "actual" longitude for a full or a partial scene.
SCENE_LL_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene lower left corner "actual" latitude at for a full or a partial scene.
SCENE_LL_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	WRS scene lower left corner "actual" longitude at for a full or a partial scene.
SCENE_LR_CORNER_LAT	8	= -90.0000 through +90.0000 degrees (with a 4-digit precision) A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.	WRS scene lower right corner "actual" latitude at for a full or a partial scene.
SCENE_LR_CORNER_LON	9	= -180.0000 through +180.0000 degrees (with a 4-digit precision) A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.	WRS scene lower right corner "actual" longitude at for a full or a partial scene.
SCENE_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	WRS scene cloud cover assessment (CCA) - Indicates the percent of a WRS scene area covered with clouds. This CCA is an average of the CCAs for all quadrants of the WRS scene.
UL_QUAD_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	Indicates the percent of upper left quadrant of the WRS scene area covered with clouds. For partial scenes, the quadrant score is for the quadrant of the actual data and not for what would be a full WRS scene.
UR_QUAD_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	Indicates the percent of upper right quadrant of the WRS scene area covered with clouds. For partial scenes, the quadrant score is for the quadrant of the actual data and not for what would be a full WRS scene.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
LL_QUAD_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	Indicates the percent of lower left quadrant of the WRS scene area covered with clouds. For partial scenes, the quadrant score is for the quadrant of the actual data and not for what would be a full WRS scene.
LR_QUAD_CCA	1–3	= 0–100 This field is included in the ETM+ Format 1 metadata only.	Indicates the percent of lower right quadrant of the WRS scene area covered with clouds. For partial scenes, the quadrant score is for the quadrant of the actual data and not for what would be a full WRS scene.
ACCA_ALGORITHM_ID_VER	22	= 22 ASCII characters The algorithm name and version numbers are determined by the Landsat 7 Project. This field is included in the ETM+ Format 1 metadata only.	Identifies the ACCA algorithm (name and version number), used by LPS in calculating the automated cloud cover assessment for this scene.
SUN_AZIMUTH_ANGLE	12	= -180.0000000 through +180.0000000 degrees (with 7-digit precision) A positive value (+) indicates angles to the East or clockwise from North. A negative value (-) indicates angles to the West or counterclockwise from North. (Leading zeros are not required)	The Sun azimuth angle at the "true" WRS scene center (LPS calculated from PCD processing).
SUN_ELEVATION_ANGLE	11	= -90.0000000 through +90.0000000 degrees (with 7-digit precision) A positive value (+) indicates a daytime scene. A negative value (-) indicates a nighttime scene. (Leading zeros are not required)	The Sun elevation angle at the "true" WRS scene center (LPS calculated from PCD processing).

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_BAND1_PRESENT	1	= "Y" indicates that Band 1 is present OR = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown This field is included in the ETM+ Format 1 metadata only.	This is the "Band 1 ON" state information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 0, where a bit set condition. (=1) indicates "Band 1 ON state" . The first error-free PCD major frame (2) associated with the scene is used to derive this value. If no valid PCD major frame falls within the scene's time boundary, then the value for the previous scene will be used. If the previous scene has no valid major frame (e.g., the first partial scene in a subinterval), then the value "U" for unknown will be used.
SCENE_BAND2_PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	Same as above with exception as noted. This is the "Band 2 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 1, where a bit set condition (=1) indicates "Band 2 ON state."
SCENE_BAND3_PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	Same as above with exception as noted. This is the "Band 3 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 2, where a bit set condition (=1) indicates "Band 3 ON state."
SCENE_BAND4_PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	Same as above with exception as noted. This is the "Band 4 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 3, where a bit set condition (=1) indicates "Band 4 ON state."
SCENE_BAND5_PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 metadata only.	Same as above with exception as noted. This is the "Band 5 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 4, where a bit set condition (=1) indicates "Band 5 ON state."

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
SCENE_BAND6_PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 1 or Format 2 metadata.	Same as above with exception as noted. This is the "Band 6/MIR ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state."
SCENE_BAND7_PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 2 metadata only.	Same as above with exception as noted. This is the "Band 7 ON" status information obtained from PCD Serial Word "B" (major frame (2), minor frame 32, word 72), bit 6, where a bit set condition (=1) indicates "Band 7 ON state."
SCENE_BAND8_PRESENT	1	(Same as SCENE_BAND1_PRESENT values and format). This field is included in the ETM+ Format 2 metadata only.	Same as above with exception as noted. This is the "Band 8 ON" status information obtained from PCD Serial Word "E" (major frame (2), minor frame 35, word 72), bit 0, where a bit set condition (=1) indicates "Band 8 ON state."
BAND1_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	The band gain condition detected at the start of a WRS scene. This information is obtained from Words 7 and 8 of the PCD/Status Data field of the first error-free VCDU in a WRS scene.
BAND2_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN)
BAND3_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN)
BAND4_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN)
BAND5_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND6_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 1 or Format 2 metadata.	(See parameter description for BAND1_GAIN)
BAND7_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_GAIN)
BAND8_GAIN	1	= "L" for a low gain condition or = "H" for a high gain condition This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_GAIN)
BAND1_GAIN_CHANGE	1	= "0" indicates no band gain change within scene or = "+" indicates a low to high band gain change within scene or = "-" indicates a high to low band gain change within scene This field is included in the ETM+ Format 1 metadata only.	Band gain change flags are generated by LPS by evaluating corresponding band gain states in adjacent ETM+ scans (major frames).
BAND2_GAIN_CHANGE	1	(Same as for BAND1_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND3_GAIN_CHANGE	1	(Same as for BAND1_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND4_GAIN_CHANGE	1	(Same as for BAND1_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND5_GAIN_CHANGE	1	(Same as for BAND1_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND6_GAIN_CHANGE	1	(Same as for BAND1_GAIN_CHANGE) This field is included in the ETM+ Format 1 or Format 2 metadata.	(See parameter description for BAND1_GAIN_CHANGE)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
BAND7_GAIN_CHANGE	1	(Same as for BAND1_GAIN_CHANGE) This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND8_GAIN_CHANGE	1	(Same as for BAND1_GAIN_CHANGE) This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_GAIN_CHANGE)
BAND1_SL_GAIN_ CHANGE	1-5	= NNNNN where: 0 = no gain change 1- 12000 = the scan line number where the first change in band gain was detected. This field is included in the ETM+ Format 1 metadata only.	This field indicates the scan line number in the scene for the first change detected in the band gain condition.
BAND2_SL_GAIN_ CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND3_SL_GAIN_ CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND4_SL_GAIN_ CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND5_SL_GAIN_ CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 1 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND6_SL_GAIN_ CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 1 or Format 2 metadata.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND7_SL_GAIN_ CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)
BAND8_SL_GAIN_ CHANGE	1-5	(Same as for BAND1_SL_GAIN_CHANGE) This field is included in the ETM+ Format 2 metadata only.	(See parameter description for BAND1_SL_GAIN_CHANGE)

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
FULL_APERTURE_CAL_ FLAG	1	= "N" indicates no full calibration activity during this scene OR = "Y" indicates a full calibration activity	This field indicates the ETM+ full calibration activity during this scene. The calibration door activity flag is interpolated from "serial word P" of the third PCD major frame, minor frame 83, word 72, bits 2 and 3.
DAY_NIGHT_FLAG	1	= "D" for day flag 'True' OR = "N" for night flag 'True'	This field indicates the day or night condition for the scene. The LPS determines the day/night condition of a scene by comparing the Sun elevation values against an angle value of 0 degrees. A scene is declared a day scene if the Sun elevation angle is greater than 0 degrees; otherwise it is declared a night scene.
END_GROUP	12	= WRS_SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected to be received by LPS in a 14-minute subinterval)	End of the third level ODL group. It indicates the end of the ETM+ Format 1 or Format 2 WRS Scene Metadata group records.
Image Q&A Data **(not an LPS metadata parameter)**			**The following parameter values are repeated for each WRS scene included in this subinterval.**
GROUP	9	= ETM_QA_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the ETM+ Format 1 or Format 2 Scene NN Q&A data group records.
SCENE_QUALITY	2	= 00-99 OR = -1 if the scene quality is not calculated	A scene quality score as described in section 4.2.2 with the first digit representing image quality and the second digit representing PCD quality. 99 represents highest quality and 00 is the worst quality score for a scene. The -1 will not be used by LPS and is specified here to be consistent with the *L7 to IGS ICD* (Applicable Document 2.1.13).
CADUS_VCDUS_RECEIVED	1–6	= 1–999999	The total number of CADUs/VCDUs received for this scene. Approximately 362,380 VCDUs are expected to be received for a 26.8-second long WRS scene. A WRS scene consists of a maximum of 375, including 40 overlap scans.
FLY_WHEEL_CADUS	1–6	= 0–999999	The total number of CADUs fly-wheeled due to sync errors.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
RS_ERR_VCDUS	1–6	= 0–999999	The total number of VCDUs with Reed-Solomon error corrected in the header field.
BCH_CORRECTED_VCDUS	1–6	= 0–999999	The total number of VCDUs with BCH errors corrected for up to 3 bits in their mission data fields.
BCH_UNCORRECTED_ VCDUS	1–6	= 0–999999	The total number of VCDUs containing uncorrected BCH errors (bits) in their mission data fields.
BIT_ERROR_RATE	1–4	= 0–9999	The number of bit errors detected over the whole length of the scene and normalized to average number of errors in 100,000 bits. BIT_ERROR_RATE = (Total Detected Bit Errors/Total Number of Bits in Subinterval) x 100,000. This BER is calculated using bit errors detected (corrected or not) during BCH checks of the input VCDUs. An input data bit error rate of 1 in 100,000 or less is considered acceptable.
ETM_TIMECODE_ ERRORS	1–3	= 0-375	The total number of ETM+ scans (major frames) detected with errors in their time code fields during processing of this subinterval scene. A maximum of 375 ETM+ scans are possible in a WRS scene.
ENTIRELY_FILLED_ SCANS	1–3	= 0–375	The total number of ETM+ major frames (maximum of 375) in this WRS scene (~26.8 seconds for 375 scans) that were entirely filled using a pre-determined fill data pattern.
PARTIALLY_FILLED_ SCANS	1–3	= 0–375	The total number of ETM+ major frames (maximum of 375) in this WRS scene that were partially filled using a pre-determined fill data pattern.
END_GROUP	9	= ETM_QA_NN where NN = 01–99	End of the third level ODL group. It indicates the end of the ETM+ Q&A data group records for WRS Scene NN.
PCD Q&A Data **(not an LPS metadata parameter)**			**The following parameter values are repeated for each WRS scene included in the subinterval.**
GROUP	9	= PCD_QA_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the PCD Q&A data group records for WRS Scene NN.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
PCD_WORDS_RECEIVED	1–6	= 0–999999	The total number of PCD words, extracted from the unpacked PCD words (one sync byte, 3 repeated data bytes, and at least 4 fill bytes), received for this scene. Approximately 107,200 packed PCD words can be received by LPS for a 26.8-second scene.
PCD_BYTE_VOTING_ERR	1–6	= 0–999999	The total number of PCD words that encountered byte-voting errors during packing (for a maximum of 107,200 words).
TOTAL_PCD_MINOR_ FRAMES	1–3	= 0–999	The total number of PCD minor frames constructed during this scene. Approximately 838 PCD minor frames can be received by LPS for a 26.8- second WRS scene.
PCD_MINOR_FRAME_ERR	1–3	= 0–999	The total number of PCD minor frames which encountered sync errors during their construction for a scene. Up to 838 minor frames for a WRS scene are expected.
FILLED_PCD_MINOR_ FRAMES	1–3	= 0–999	The total number of PCD minor frames which required a data fill during their construction.
FILLED_PCD_MAJOR_ FRAMES	1	= 0–9	The total number of PCD major frames which required a data fill during their construction. Approximately 7 major frames can be received by LPS for a 26.8-second long WRS scene.
END_GROUP	9	= PCD_QA_NN where NN = 01–99	End of the third level ODL group. It indicates the end of the PCD Q&A data group records for WRS Scene NN.
Processed PCD Q&A Data **(not an LPS metadata parameter)**			**The following parameter values are repeated for each WRS scene included in the subinterval.**
GROUP	19	= PROCESSED_PCD_QA_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the processed PCD Q&A data group records for WRS Scene NN.
TOTAL_ATTITUDE_ POINTS	1	= 0–9	The total number of spacecraft attitude data points (quaternations) received and processed from the PCD associated with this scene. Approximately 6.5 spacecraft attitude data points can be received for a 26.8-second WRS scene.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
REJECTED_ATTITUDE_ POINTS	1	= 0–9	The total number of spacecraft attitude data points (quaternations) found to fail the PCD quality checks. The rejected data points are flagged and included in the PCD file associated with this WRS scene.
MISSING_ATTITUDE_ POINTS	1	= 0–9	The total number of spacecraft attitude data points (quaternations) found missing during PCD quality checks. The missing data points are flagged and included in the PCD file associated with this WRS scene.
TOTAL_EPHEMERIS_ POINTS	1	= 0–9	The total number of ephemeris data points received and processed from the PCD of this scene. Approximately 7 ephemeris data points can be received for a 26.8-second long WRS scene.
REJECTED_EPHEMERIS_ POINTS	1	= 0–9	The total number of spacecraft ephemeris data points found to fail LPS PCD quality checks. The rejected data points are flagged and included in the PCD file associated with this WRS scene.
MISSING_EPHEMERIS_ POINTS	1	= 0–9	The total number of spacecraft ephemeris data points found missing during PCD quality checks. The missing data points are flagged and included in the PCD file associated with this WRS scene.
END_GROUP	19	= PROCESSED_PCD_QA_NN where NN = 01–99	End of the third level ODL group. It indicates the end of the processed PCD Q&A data group records for WRS Scene NN.
END_GROUP	17	= METADATA _SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected to be received by LPS in a 14-minute subinterval)	End of the second level ODL group. It indicates the end of the ETM+ Format 1 or Format 2 Scene NN level metadata group records.
END_GROUP	26	= SUBINTERVAL_METADATA_ FMT_m m = 1 for Format 1 OR m = 2 for Format 2	End of the second level ODL group. It indicates the end of the ETM+ Format 1 or Format 2 subinterval level Metadata group records.

Parameter Name	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
END_GROUP	13	= METADATA_FILE	End of the first level ODL group. It indicates the end of the LPS Metadata File Level Group records for an ETM+ Format 1 or Format 2 subinterval.
END			End of Metadata file marker.

4.2.2 Algorithm for Calculation of Scene Quality

A two digit number that separates image and PCD data quality is used by the LPS for Landsat 7. The first digit represents image data quality and can range in value from 0 to 9. The second digit represents PCD quality and can range in value from 0 to 9. The formula for the combined score is:

image score * 10 + PCD score

The following paragraphs describe how the image quality and PCD quality scores are assigned.

4.2.2.1 Image Quality Component

The image quality digit is based on the number and distribution of bad scans or equivalent bad scans in a scene. It is computed by dividing the total number of filled minor frames for a scene by 6313 (the nominal number of image data minor frames in a major frame for 30 meter bands). This will give a number of equivalent bad scans.

The distribution of filled minor frames is characterized as being either clustered or scattered. A cluster of 128 bad scans will still yield a scene with a cluster of 246 good scans which is almost 2/3 of a scene. A scattering of 128 band scans may make the entire image worthless.

What defines clustering versus scattering? It is proposed that bad scan lines are clustered if they occur within a grouping of 128 contiguous scans (approximately 1/3 of a scene). Errors are characterized as scattered if they occur outside the bounds of 128 contiguous scans. The image score is assigned according to the rules in Table 4-18.

Table 4-18: Scene Quality Score - Image Quality Component

SCORE	IMAGE QUALITY
9	no errors detected, a perfect scene
8	≤ 4 equivalent bad scans, clustered
7	≤ 4 equivalent bad scans, scattered
6	≤ 16 equivalent bad scans, clustered
5	≤ 16 equivalent bad scans, scattered
4	≤ 64 equivalent bad scans, clustered
3	≤ 64 equivalent bad scans, scattered
2	≤ 128 equivalent bad scans, clustered
1	≤ 128 equivalent bad scans, scattered
0	> 128 equivalent bad scans, scattered (> 33% of the scene is bad)

4.2.2.2 PCD Quality Component

The PCD quality digit is based on the number and distribution of filled PCD minor frames. There are approximately 7 PCD major frames for a standard WRS scene comprised of 375 scans. Each PCD major frame consists of 128 minor frames or 16,384 bytes. Clustering of filled PCD minor frames indicates that errors are localized whereas scattering indicates that numerous or all major frames may be affected.

What defines clustering versus scattering? Each PCD minor frame has 16 jitter measurements and corresponds to 30 milliseconds or approximately 1/2 of a scan. Two minor frames correspond to a single scan while 256 minor frames (i.e., 2 PCD major frames) correspond to 128 scans or approximately 1/3 of a scene.

Like the image data, it is proposed that bad PCD minor frames are clustered if they occur within a grouping of 2 contiguous PCD major frames (1/3 of a scene). Errors are characterized as scattered if they occur outside the bounds of contiguous PCD major frames. The PCD score is assigned according to the rules in Table 4-19.

Table 4-19: Scene Quality Score - PCD Quality Component

SCORE	PCD QUALITY
9	no PCD errors detected
8	≤ 8 bad minor frames, clustered
7	≤ 8 bad minor frames, scattered
6	≤ 32 bad minor frames, clustered
5	≤ 32 bad minor frames, scattered
4	≤ 128 bad minor frames, clustered
3	≤ 128 bad minor frames, scattered
2	≤ 256 bad minor frames, clustered
1	≤ 256 bad minor frames, scattered
0	> 256 bad minor frames, scattered (>33% of the scene is bad)

4.2.2.3 Scene Quality

The score calculated using the methods described above are recorded in the scene level metadata under the keyword SCENE_QUALITY. Using this scoring system the highest possible rating for an image would be 99, the lowest 00. The score treats missing image data more critically than missing or filled PCD data. For example, an image with 16 filled scans that are scattered and with errorless PCD would have a 59 score whereas an image with intact image data and a 32 filled PCD minor frames that are scattered would receive a score of 95. The rationale is that PCD is less important because missing values can always be extrapolated or interpolated to enable level 1 processing. Missing image data cannot be retrieved and thus impacts the user more severely than missing PCD. The score construct unambiguously alerts the user to image data deterioration. The value of -1 is reserved for systems that do not calculate the scene quality. LPS will always calculate a scene quality value, but this is mentioned here to be consistent with the *L7to IGS ICD* (Applicable Document 2.1.13).

4.2.3 Metadata File Format - ODL Examples

The examples in the following sections illustrate the structure of the LPS metadata files. The values shown for the metadata parameters are in the ODL format. It should be noted that the values used in these examples may not be accurate because no attempt has been made to map them to the illustrated metadata subinterval and/or the WRS scene boundaries.

The ODL procedures described in Applicable Document 2.1.6 are used to construct the subinterval, WRS scenes, and individual WRS scene metadata GROUPS. GROUP statements are presented in bold in this DFCB only. (Bold statements are not required in the metadata implementation.) In addition, the comment statements enclosed within "/*" and "*/" are shown to clarify the metadata format construction. They are not explicitly required in the implemented metadata file format.

4.2.3.1 ODL Example - Format 1 Metadata File

/* LPS Level 0R subinterval Metadata file - Format 1 ***/**

GROUP = METADATA_FILE

/* Metadata file identification - Format 1 ***/**

GROUP = METADATA_FILE_INFO
FILE_NAME = "L71EDC119813511010.MTA"
FILE_CREATION_ DATE_TIME = 1998-05-15T13:30:25Z
FILE_VERSION_NO = 0
STATION_ID = "EDC"
SOFTWARE_VERSION_NO = "2.1.0"
L7_CPF_NAME = "L7CPF19981001_19981231.01"
END_GROUP = METADATA_FILE_INFO

/* Subinterval level metadata - Format 1 */

GROUP = SUBINTERVAL_METADATA_FMT_1
SPACECRAFT_ID = "Landsat7"
SENSOR_ID = "ETM+"
CONTACT_PERIOD_START_TIME = 1998-135T11:23:10Z
CONTACT_PERIOD_STOP_TIME = 1998-135T11:37:01Z
STARTING_PATH = 029
STARTING_ROW = 020
ENDING_ROW = 045
SUBINTERVAL_START_TIME = 1998-135T11:25:01.1234567Z
SUBINTERVAL_STOP_TIME = 1998-135T11:35:05.7654321Z
TOTAL_ETM_SCANS = 8853
PCD_START_TIME = 1998-135T11:25:01.1234567Z
PCD_STOP_TIME = 1998-135T11:35:05.7654321Z
TOTAL_ PCD_MAJOR_FRAMES = 147
SUBINTERVAL_UL_CORNER_LAT = 41.5432 /* Sample Results are */
SUBINTERVAL_UL_CORNER_LON = -96.5432 /* shown; not related*/
SUBINTERVAL_UR_CORNER_LAT = 41.4321 /* to other results */
SUBINTERVAL_UR_CORNER_LON = -96.6543 /* included in this */
SUBINTERVAL_LL_CORNER_LAT = -96.6543 /* Example */
SUBINTERVAL_LL_CORNER_LON = -96.3543
SUBINTERVAL_LR_CORNER_LAT = 41.3432
SUBINTERVAL_LR_CORNER_LON = -96.6543
ETM_LAST_ON_TIME = 1998-135T11:20:01.1234567Z

```
    ETM_LAST_OFF_TIME = 1998-135T09:25:01.7654321Z
    UT1_CORRECTION = 0.12345
    BAND1_PRESENT = "Y"
    BAND2_PRESENT = "Y"
    BAND3_PRESENT = "Y"
    BAND4_PRESENT = "Y"
    BAND5_PRESENT = "Y"
    BAND6_PRESENT = "Y"
    TOTAL_WRS_SCENES = 26
    PARTIAL_WRS_SCENES = 2
    TOTAL_FILES = 35
    BAND1_FILE_NAME = "L71EDC119813511010.B10"
    BAND2_FILE_NAME = "L71EDC119813511010.B20"
    BAND3_FILE_NAME = "L71EDC119813511010.B30"
    BAND4_FILE_NAME = "L71EDC119813511010.B40"
    BAND5_FILE_NAME = "L71EDC119813511010.B50"
    BAND6_FILE_NAME = "L71EDC119813511010.B60"
    MSCD_FILE_NAME = "L71EDC119813511010.MSD"
    PCD_FILE_NAME = "L71EDC119813511010.PCD"
    CAL_FILE_NAME = "L71EDC119813511010.CAL"

/* Metadata for all WRS scenes included in the Format 1 subinterval */
/* Note:  The WRS scene centers correspond to Band 1 scan times */

GROUP = METADATA_SCENE_01
  GROUP = WRS_SCENE_01
    WRS_SCENE_NO = 1
    FULL_OR_PARTIAL_SCENE = "P"
    BROWSE_FILE_NAME = "L71EDC119813511010.R01"
    WRS_PATH = 029
    WRS_ROW = 020
    SCENE_CENTER_SCAN_NO = 95
    SCENE_CENTER_SCAN_TIME = 1998-135T11:26:45.1234567Z
    SCENE_CENTER_LAT =   42.1234
    SCENE_CENTER_LON = -96.7654
    HORIZONTAL_DISPLAY_SHIFT =  275
    SCENE_UL_CORNER_LAT =   41.5432
    SCENE_UL_CORNER_LON = -96.5432
    SCENE_UR_CORNER_LAT =   41.4321
    SCENE_UR_CORNER_LON = -96.6543
    SCENE_LL_CORNER_LAT =   41.6543
    SCENE_LL_CORNER_LON = -96.3543
    SCENE_LR_CORNER_LAT =   41.3432
    SCENE_LR_CORNER_LON = -96.6543
    SCENE_CCA = 52
    UL_QUAD_CCA = 99
    UR_QUAD_CCA = 99
    LL_QUAD_CCA = 4
    LR_QUAD_CCA = 6
    ACCA_ALGORITHM_ID_VER = "ACCA_11MAY98_9999E.ALG"
    SUN_AZIMUTH_ANGLE = 20.1234567
    SUN_ELEVATION_ANGLE = 20.1234567
```

```
        SCENE_BAND1_PRESENT = "Y"
        SCENE_BAND2_PRESENT = "Y"
        SCENE_BAND3_PRESENT = "Y"
        SCENE_BAND4_PRESENT = "Y"
        SCENE_BAND5_PRESENT = "Y"
        SCENE_BAND6_PRESENT = "Y"
        BAND1_GAIN = "H"
        BAND2_GAIN = "H"
        BAND3_GAIN = "H"
        BAND4_GAIN = "H"
        BAND5_GAIN = "H"
        BAND6_GAIN = "L"
        BAND1_GAIN_CHANGE = "0"
        BAND2_GAIN_CHANGE = "0"
        BAND3_GAIN_CHANGE = "0"
        BAND4_GAIN_CHANGE = "0"
        BAND5_GAIN_CHANGE = "-"
        BAND6_GAIN_CHANGE = "0"
        BAND1_SL_GAIN_CHANGE = 0
        BAND2_SL_GAIN_CHANGE = 0
        BAND3_SL_GAIN_CHANGE = 0
        BAND4_SL_GAIN_CHANGE = 0
        BAND5_SL_GAIN_CHANGE = 9000
        BAND6_SL_GAIN_CHANGE = 0
        FULL_APERTURE_CAL_FLAG = "N"
        DAY_NIGHT_FLAG = "D"
    END_GROUP = WRS_SCENE_01

/* Scene image data quality and accounting (Q&A) data */

    GROUP = ETM_QA_01
      SCENE_QUALITY      = 99
      CADUS_VCDUS_RECEIVED = 543926
      FLYWHEEL_CADUS = 123456
      RS_ERR_VCDUS = 123
      BCH_CORRECTED_VCDUS = 456
      BCH_UNCORRECTED_VCDUS = 12
      BIT_ERROR_RATE = 10
      ETM_TIMECODE_ERRORS = 12
      ENTIRELY_FILLED_SCANS = 12
      PARTIALLY_FILLED_SCANS = 123
    END_GROUP = ETM_QA_01

/* Scene PCD quality and accounting information */

    GROUP = PCD_QA_01
      PCD_WORDS_RECEIVED = 106340
      PCD_BYTE_VOTING_ERR = 106
      TOTAL_PCD_MINOR_FRAMES = 202
      PCD_MINOR_FRAME_ERR = 202
      FILLED_PCD_MINOR_FRAMES = 200
      FILLED_PCD_MAJOR_FRAMES = 1
```

```
            END_GROUP = PCD_QA_01

        /* Processed PCD quality and accounting information on scene */

            GROUP = PROCESSED_PCD_QA_01
               TOTAL_ATTITUDE_POINTS = 6
               REJECTED_ATTITUDE_POINTS = 1
               MISSING_ATTITUDE_POINTS = 1
               TOTAL_EPHEMERIS_POINTS = 6
               REJECTED_EPHEMERIS_POINTS = 1
               MISSING_EPHEMERIS_POINTS = 1
            END_GROUP = PROCESSED_PCD_QA_01

         END_GROUP = METADATA _SCENE_01

            •   /* Repeat METADATA _SCENE_NN until NN > 26, */
            •   /* the total number of WRS scenes, full or partial, present in this */
            •   /* subinterval example */

         GROUP = METADATA_SCENE_NN

                /* Scene NN Metadata ODL group */

         END_GROUP = METADATA_SCENE_NN

      END_GROUP = SUBINTERVAL_METADATA_FMT_1

END_GROUP = METADATA_FILE

END
```

4.2.3.2 ODL Example - Format 2 Metadata File

```
/* LPS Level 0R subinterval Metadata file - Format 2 */

GROUP = METADATA_FILE

        /* Metadata file identification - Format 2 */

        GROUP = METADATA_FILE_INFO
            FILE_NAME = "L71EDC229813511010.MTA"
            FILE__CREATION_ DATE_TIME = 1998-05-15T13:30:26Z
            FILE_VERSION_NO = 0
            STATION_ID = "EDC"
            SOFTWARE_VERSION_NO = "2.1.0"
            L7_CPF_NAME = "L7CPF19981001_19981231.01"
        END_GROUP = METADATA_FILE_INFO

        /* Subinterval level metadata - Format 2 */

        GROUP = SUBINTERVAL_METADATA_FMT_2
            SPACECRAFT_ID = "Landsat7"
            SENSOR_ID = "ETM+"
            CONTACT_PERIOD_START_TIME = 1998-135T11:23:10Z
            CONTACT_PERIOD_STOP_TIME = 1998-135T11:37:01Z
            STARTING_PATH = 029
            STARTING_ROW = 020
            ENDING_ROW = 045
            SUBINTERVAL_START_TIME = 1998-135T11:25:01.1234567Z
            SUBINTERVAL_STOP_TIME = 1998-135T11:35:05.7654321Z
            TOTAL_ETM_SCANS = 8853
            PCD_START_TIME = 1998-135T11:25:01.1234567Z
            PCD_STOP_TIME = 1998-135T11:35:05.7654321Z
            TOTAL_ PCD_MAJOR_FRAMES = 147
            SUBINTERVAL_UL_CORNER_LAT =   41.5432  /* Sample Results are shown; */
            SUBINTERVAL_UL_CORNER_LON = -96.5432  /* not related to other results */
            SUBINTERVAL_UR_CORNER_LAT =   41.4321  /* included in this Example */
            SUBINTERVAL_UR_CORNER_LON = -96.6543
            SUBINTERVAL_LL_CORNER_LAT =  -96.6543
            SUBINTERVAL_LL_CORNER_LON = -96.3543
            SUBINTERVAL_LR_CORNER_LAT =   41.3432
            SUBINTERVAL_LR_CORNER_LON = -96.6543
            ETM_LAST_ON_TIME = 1998-135T11:15:01.1234567Z
            ETM_LAST_OFF_TIME = 1998-135T09:25:01.7654321Z
            UT1_CORRECTION = 0.1234567
            BAND6_PRESENT = "Y"
            BAND7_PRESENT = "Y"
            BAND8_PRESENT = "Y"
            TOTAL_WRS_SCENES = 26
            PARTIAL_WRS_SCENES = 2
            TOTAL_FILES = 8
```

```
        BAND6_FILE_NAME = "L71EDC219813511010.B60"
        BAND7_FILE_NAME = "L71EDC219813511010.B70"
        BAND8_FILE1_NAME = "L71EDC219813511010.B81"
        BAND8_FILE2_NAME = "L71EDC219813511010.B82"
        BAND8_FILE3_NAME = "L71EDC219813511010.B83"
        MSCD_FILE_NAME = "L71EDC219813511010.MSD"
        PCD_FILE_NAME = "L71EDC219813511010.PCD"
        CAL_FILE_NAME = "L71EDC219813511010.CAL"

/* WRS scene-by-scene metadata for this Level 0R subinterval */
/* Note:  The WRS scene centers correspond to Band 7 scan times */

    GROUP = METADATA_SCENE_01

      GROUP = WRS_SCENE_01
        WRS_SCENE_NO = 1
        FULL_OR_PARTIAL_SCENE = "P"
        WRS_PATH = 029
        WRS_ROW = 020
        SCENE_CENTER_SCAN_NO = 95
        SCENE_CENTER_SCAN_TIME = 1998-135T11:26:45.1234567Z
        SCENE_CENTER_LAT =   42.1234
        SCENE_CENTER_LON = -96.7654
        HORIZONTAL_DISPLAY_SHIFT =  275
        SCENE_UL_CORNER_LAT =   41.5432
        SCENE_UL_CORNER_LON = -96.5432
        SCENE_UR_CORNER_LAT =   41.4321
        SCENE_UR_CORNER_LON = -96.6543
        SCENE_LL_CORNER_LAT =   41.6543
        SCENE_LL_CORNER_LON = -96.3543
        SCENE_LR_CORNER_LAT =   41.3434
        SCENE_LR_CORNER_LON = -96.6543
        SUN_AZIMUTH_ANGLE = 20.1234567
        SUN_ELEVATION_ANGLE = 20.1234567
        SCENE_BAND6_PRESENT = "Y"
        SCENE_BAND7_PRESENT = "Y"
        SCENE_BAND8_PRESENT = "Y"
        BAND6_GAIN = "H"
        BAND7_GAIN = "H"
        BAND8_GAIN = "H"
        BAND6_GAIN_CHANGE = "0"
        BAND7_GAIN_CHANGE = "-"
        BAND8_GAIN_CHANGE = "0"
        BAND6_SL_GAIN_CHANGE = 0
        BAND7_SL_GAIN_CHANGE = 9000
        BAND8_SL_GAIN_CHANGE = 0
        FULL_APERTURE_CAL_FLAG = "N"
        DAY_NIGHT_FLAG: "D"
      END_GROUP = WRS_SCENE_01

    /* Scene Image Data quality and accounting (Q&A) data */
```

```
        GROUP = ETM_QA_01
            SCENE_QUALITY = 99
            CADUS_VCDUS_RECEIVED = 543926
            FLYWHEEL_CADUS = 123456
            RS_ERR_VCDUS = 123
            BCH_CORRECTED_VCDUS = 456
            BCH_UNCORRECTED_VCDUS = 12
            BIT_ERROR_RATE = 99
            ETM_TIMECODE_ERRORS = 12
            ENTIRELY_FILLED_SCANS = 12
            PARTIALLY_FILLED_SCANS = 123
        END_GROUP = ETM_QA_01

    /* Scene PCD quality and accounting information */

        GROUP = PCD_QA_01
            PCD_WORDS_RECEIVED = 106341
            PCD_BYTE_VOTING_ERR = 106
            TOTAL_PCD_MINOR_FRAMES = 202
            PCD_MINOR_FRAME_ERR = 202
            FILLED_PCD_MINOR_FRAMES = 199
            FILLED_PCD_MAJOR_FRAMES = 1
        END_GROUP = PCD_QA_01

    /* Processed PCD quality and accounting information on scene */

        GROUP = PROCESSED_PCD_QA_01
            TOTAL_ATTITUDE_POINTS = 6
            REJECTED_ATTITUDE_POINTS = 1
            MISSING_ATTITUDE_POINTS = 1
            TOTAL_EPHEMERIS_POINTS = 6
            REJECTED_EPHEMERIS_POINTS = 1
            MISSING_EPHEMERIS_POINTS = 1
        END_GROUP = PROCESSED_PCD_QA_01

    END_GROUP = METADATA_SCENE_01


    • /* Repeat METADATA_SCENE_NN GROUP until NN > 26, */
    • /* the total number of WRS scenes, full or partial, present in this */
    • /* subinterval example */

    GROUP = METADATA _SCENE_NN

        /* Scene NN Metadata ODL group */

    END_GROUP = METADATA_SCENE_NN

END_GROUP = SUBINTERVAL_METADATA_FMT_2

END_GROUP = METADATA_FILE
```

END

4.3 Multiband Browse File Format (HDF RIS24)

The LPS produces a multiband scene browse for each of the WRS scenes identified during Level 0R processing of an ETM+ Format 1 subinterval. Each multiband scene browse is a reduced size image which is produced from three operator selected bands of a WRS scene received in an ETM+ Format 1 subinterval. Each LPS produced multiband scene browse image is radiometrically corrected, reduced using the Wavelet algorithm, linear contrast stretched, compressed using HDF JPEG and output in the HDF RIS24 file format for transfer to the EDC DAAC. Each LPS produced multiband scene browse is also identified in the metadata file associated with its ETM+ Format 1 subinterval. An LPS multiband scene browse image is generated from the three ETM+ Format 1 bands (1 through 5 only) selected by the operator. No multiband scene browse images are generated by LPS for the ETM+ Format 2 bands (6, 7, and 8). The selection of these bands, if necessary, can be modified by the operator before the start of Level 0R processing of a Landsat 7 contact period.

This section provides specific details on the multiband-scene browse image (HDF RIS24 file) generated by the LPS. Additional and reference information on the generation of HDF RIS24 formatted multiband scene browse file is provided in Applicable Document 2.1.8. An overview of the LPS-produced multiband multiband-scene browse image is provided in Figure 4-6.

4.3.1 Multiband Browse File Overview

An LPS multiband-scene browse file consists of an HDF RIS24 image object and ancillary information on the source (Format 1) band data, band data reduction, linear contrast stretch, and multiband scene browse labeling. A multiband scene browse, produced from a set of three Format 1 bands, consists of a 24-bit raster image (RIS24) which is interleaved by pixel (DFIL_PIXEL) and reduced to approximately 185 KB in size after HDF JPEG compression. The resulting multiband scene browse image has the same aspect ratio as the source Format 1 band arrays. The output size of the multiband scene browse image depends on the size of the WRS scene (operational parameters) defined in the LPS. The nominal size of a WRS scene in LPS (using Format 1 Bands 1–5) is expected to be 6,600 pixels (number of bytes in a scan line) x 6,000 scans lines (Section 4.1.1.2).

The LPS uses three Wavelet runs (a reduction factor of 64) for reducing each radiometrically calibrated Format 1 band image array to a 825 pixels (bytes) x 750 lines reduced size band image array (an LPS interim product before the generation of a multiband scene browse). Figure 4-6 provides an interim view of the LPS multiband scene browse image consisting of three reduced size band image arrays. After completion of the three Wavelet runs, the size of the reduced size three band image array is approximately 1.86 MB. Next, the LPS applies a standard contrast stretch to each band of the reduced size band image arrays. The LPS uses a saturating linear contrast stretch for the LPS multiband scene browse images. The processing algorithm for the saturating linear contrast stretch is the same as used

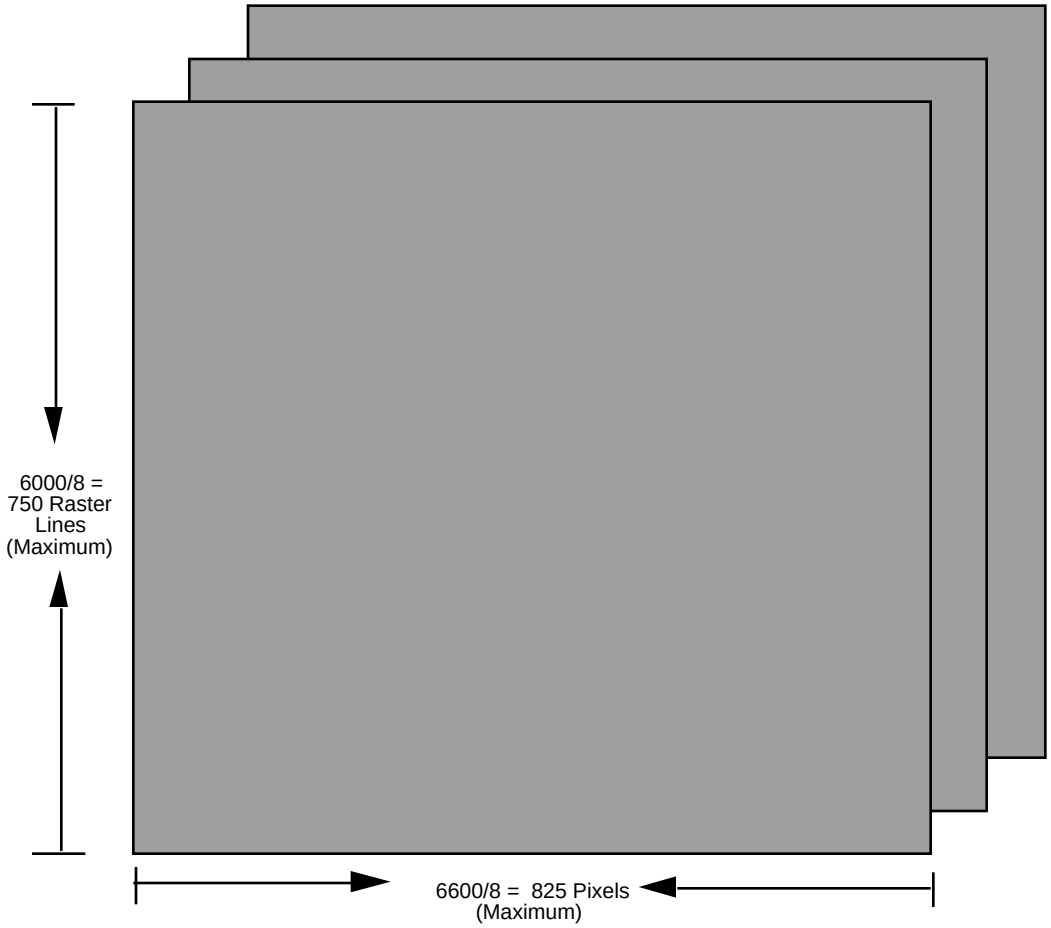
by the Landsat 7 International Ground Stations (IGS) (Applicable Document 2.1.13). Details on the saturating linear contrast stretch algorithm are provided in the LPS System Requirements Specification (SRS) (Applicable Document 2.1.14). The saturating linear contrast stretch algorithm nominally clips the upper and lower 2.5% from the reduced size band image's (array's) contrast distribution. The band image contrast clipping percentile is an operator selectable parameter. The contrast clipping percentile used in the generation of an LPS output multiband scene browse image is noted in its annotation (Table 4-21).

The LPS merges the three reduced size and linearly contrast stretched band image arrays by pixel interleaving (HDF DFIL_PIXEL). The LPS then uses HDF JPEG (compression utility) to compress the reduced band image arrays to approximately 185 KB in size. The JPEG compression step produces a multiband scene browse image, in HDF RIS24 format, which is suitable for transfer to the EDC DAAC.

The LPS may receive partial WRS scenes (with fewer than 6,000 scan data lines) at the start or end of a subinterval. A partial WRS scene is treated similar to a full WRS scene for generating a multiband scene browse. The partial WRS scenes in the band files are not filled to the full length of the WRS scenes. Also, the LPS does not insert any fill data above or below the partial WRS scene band data before generating the multiband scene browse. The multiband scene browse image for a partial WRS scene is thus constructed from the actual band data only.

Tables 4-20 and 4-21 contain data reduction, linear contrast stretch and data compression parameters and labeling information associated with the LPS produced multiband scene browse HDF RIS24 object. Data reduction, linear contrast stretch and JPEG data compression parameters can be modified by an LPS operator before the start of a Landsat 7 contact period. Only one multiband scene browse image (one HDF object) is included in an HDF RIS24 file. The source WRS scene (partial or full) used in generating a multiband scene browse image determines the RIS24 file size.

Wavelet Reduced Band Image Arrays
(Before Pixel Interlace and JPEG are Applied)



Notes:

A. Operator selected bands are radiometrically corrected

B. After 3 Wavelet Runs:
- Single band browse size: 750x825 = 0.62 MB
- Multiband browse file size: 3x 0.62 = 1.86 MB
(3 reduced size bands, no JPEG compression)
- Wavelet reduction factor: 64
- A linear contrast stretch with a nominal of 2.5% clipping is applied
- Reduced bands are merged using pixel interlace (DFIL_PIXEL)

C. After Pixel Interlace and JPEG Compression
- HDF JPEG compressed multiband browse image size: **~185 KB (to EDC DAAC)**
(HDF JPEG compression quality factor: 70)

D. The multiband scene browse image aspect ratio is maintained throughout processing

Figure 4-6: Multiband-Scene Browse RIS24 File

Table 4-20: Multiband Browse File - HDF RIS24 Object Definition (Parameter Values)

RIS24 Object Definition Parameters	Type	Size	Values, Format, Range and Units	Parameter Description / Remarks
image_file_name	char8	22	= L7XsssfnYYDOYHHuuv.xxx where xxx = "R"nn and, nn = 01–99 "R" indicates a multiband-scene browse file.	Complete details on the LPS file naming convention are provided in Section 3.4. At present, approximately 35 multiband scene browses are expected in a 14-minute long subinterval.
image_dimension_width	int32	1	= 825 pixels per scan line in each image plane	Based on a scan line length of 6,600 pixels/bytes (Section 4.1.1.2) and 3 Wavelet runs (Table 4-19).
image_dimension_height	int32	1	= 750 scan lines in each image plane	Based on a WRS scene size of 6,000 scan lines, including scene overlaps (Section 4.1.1.2), and 3 Wavelet runs (Table 4-19).
image_dimension_depth	int32	1	= 3	Implies 3 byte deep pixels for a 3 (multi) band scene browse.
image_interlace_il	int32	1	= DFIL_PIXEL (HDF uses an int32 type JPEG code)	Interlace by pixel (DFIL_PIXEL) is the default interlace mode for reading RIS24 images using HDF utilities.
image_compression	int32	8	= COMP_JPEG (HDF uses an int32 type JPEG code)	A multiband scene browse size is approximately 1.86 MB after three Wavelet runs (a reduction factor of 64) on the scene data from three bands. The LPS uses HDF JPEG to further compress the multiband scene browse file size to approximately 150 KB before sending it to the EDC DAAC (ECS) for storage.
compression_quality_ factor	N/A	1	= 90	Reduces LPS output multiband scene browse size to approximately **185 KB** using the HDF JPEG.

Table 4-21: Multiband Browse RIS24 File Label and Object Description (Parameter Values)

RIS24 Object Annotation Information ** Multiband Browse ASCII Text lines are shown in ** double quotes. Omit in HDF implementation.	Size (ASCII Bytes)	Value, Format, Range, and Units	Parameter Description / Remarks
multiband_browse_file_label	22	=L7XsssfnYYDOYHHuuv.xxx where xxx = "R"nn and, nn = 01–99 for a multiband scene browse number within a subinterval. "R" indicates a multiband-scene browse file.	Complete details on the LPS file naming convention are provided in Section 3.4. At present, approximately 35 multiband scene browses are expected in a 14-minute long subinterval.
ref_metadata_file_name	22	=L7XsssfnYYDOYHHuuv.xxx where xxx = "MTA"	See Section 3.4 for details on the LPS file naming convention.
band_IDs	3	= RGB where R = 1–5, G = 1–5, and B = 1–5	The three ETM+ Format 1 bands (each being 1 of the 5) selected for generating the multiband scene browse. LPS operation may assign three ETM+ bands as the default bands for browse generation.
wavelet_runs	1	= 3 The LPS will use 3 Wavelet runs in its multiband browse scheme.	The number of Wavelet runs used to generate the multiband scene browse. Each run reduces the input image size to 1/4th.
clipping_percentile	4	= 0 - 100% Nominally set to 2.5% (Default) for a linear contrast stretch.	An LPS operator specified percentile value used in clipping the top (near 255) and bottom (near 0) ends of the multiband scene browse contrast values. This values is also used by the LPS in determining and applying a linear contrast stretch to the remaining distribution of the image contrast values.

Acronym List

ACCA	Automated Cloud Cover Assessment
ADS	Attitude Displacement Sensors
AOS	Acquisition of Signal
BCH	Bose-Chaudhuri-Hocquenghem
BER	Bit Error Rate
CADU	Channel Access Data Unit
CAL	LPS file extension for "internal Calibration Data"
Cal. Data	Calibration Data
CCB	Configuration Control Board
CCR	Configuration Change Request
CCSDS	Consultative Committee on Space Data System
CFPA	Cold Focal Plane Array
CPF	Calibration Parameter file
DAAC	Distributed Active Archive Center
DCN	Document Change Notice
DFCB	Data Format Control Book
DOY	Day of Year
ECS	EOSDIS Core System
EDC	EROS Data Center
EDC DAAC	EDC Distributed Active Archive Center
EOL	End of Line
EOS	Earth Observing System
EOSDIS	Earth Observation Data Information System
EROS	Earth Resources Observation System
ESDIS	Earth Science Data & Information System
ETM+	Enhanced Thematic Mapper plus
EU	Engineering Unit
F&PS	Functional and Performance Specification
FHS	First Half Scan Error
GB	Gigabytes
GMT	Greenwich Mean Time
GNC	Gatineau, Canada (Satellite ground station)
GSFC	Goddard Space Flight Center
HDF	Hierarchical Data Format
HDS	Horizontal Display Shift
IAS	Image Assessment System
ICD	Interface Control Document
ID	Identification
IGS	International Ground Station
IMU	Inertial Measurement Unit
JPEG	Joint Photographic Expert Group

L7	Landsat 7
LAN	Local Area Network
LSC	Line Sync Code
LGS	Landsat 7 Ground Station
LHS	Left Hand Side
LOS	Loss of Signal
LPS	Landsat 7 Processing System
MD	Maryland
MOC	Mission Operations Center
MO&DSD	Mission Operations and Data Systems Directorate
MOSDD	Mission Operations and Systems Development Division
MSD	LPS file extension for "MSCD"
MSCD	Mirror Scan Correction Data
MTA	LPS file extension for "Metadata"
Mux	Multiplexer
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
ODL	Object Description Language
PCD	Payload Correction Data
PVL	Parameter Value Language
RHS	Right Hand Side
RIS24	24-bit Raster Image Set
Q&A	Quality and Accounting
SRS	Software Requirements Specification
SHS	Second Half Scan Error
SCN DIR	Scan Direction
SLD	Scan Line Data
SV	Space Vehicle (Spacecraft)
TBD	To be determined
TBR	To be reviewed/resolved
TLM	Telemetry
UTC	Universal Time Code
VCDU	Virtual Channel Data Unit
WRS	Worldwide Reference Systems